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ON

AGRICULTURE IN INDIA

Volume I

Part II

EVIDENCE

OF

Officers serving under the Government of India

CALCUTTA: GOVERNMENT OF INDIA
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INTERIM REPORT

To

THE KING'S MOST EXCELLENT MAJESTY.

May It Please Your Majesty,

We, the Commissioners appointed to examine and report on the present conditions of agricultural and rural economy in British India, and to make recommendations for the improvement of agriculture and to promote the welfare and prosperity of the rural population ; in particular, to investigate :—(*a*) the measures now being taken for the promotion of agricultural and veterinary research, experiment, demonstration and education, for the compilation of agricultural statistics, for the introduction of new and better crops and for improvement in agricultural practice, dairy farming and the breeding of stock ; (*b*) the existing methods of transport and marketing of agricultural produce and stock ; (*c*) the methods by which agricultural operations are financed and credit afforded to agriculturists ; (*d*) the main factors affecting rural prosperity and the welfare of the agricultural population ; and to make recommendations ; availing ourselves of Your Majesty's permission to report our proceedings from time to time, desire to submit to Your Majesty certain additional minutes of the evidence which we have taken on the subject of our Inquiry.

All of which we most humbly submit for Your Majesty's most gracious consideration.

(Signed) LINLITHGOW,
Chairman.
(,,) H. S. LAWRENCE.
(,,) T. H. MIDDLETON.
(,,) J. MACKENNA.
(,,) H. CALVERT.
(,,) N. GANGULEE.
(,,) L. K. HYDER.
(,,) B. S. KAMAT.

(Signed) J. A. MADAN,
(,,) F. W. H. SMITH,
Joint Secretaries.

25*th May* 1927.

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TERMS OF REFERENCE

Generally,

To examine and report on the present conditions of agriculture and rural economy in British India and to make recommendations for the improvement of agriculture and the promotion of the welfare and prosperity of the rural population;

In particular to investigate—

(*a*) the measures now being taken for the promotion of agricultural and veterinary research, experiment, demonstration and education, for the compilation of agricultural statistics, for the introduction of new and better crops and for improvement in agricultural practice, dairy farming and the breeding of stock;

(*b*) the existing methods of transport and marketing of agricultural produce and stock;

(*c*) the methods by which agricultural operations are financed and credit afforded to agriculturists;

(*d*) the main factors affecting rural prosperity and the welfare of the agricultural population;

and to make recommendations.

It will not be within the scope of the Commission's duties to make recommendations regarding the existing system of landownership and tenancy or of the assessment of land revenue and irrigation charges, or the existing division of functions between the Government of India and the local Governments. But the Commission shall be at liberty to suggest means whereby the activities of the Governments in India may best be co-ordinated and to indicate directions in which the Government of India may usefully supplement the activities of local Governments.

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QUESTIONNAIRE

Part I

1. Research.

(*a*) Have you suggestions to advance for the better organisation, administration and financing of—

(*i*) All research affecting the welfare of the agriculturist, including research into the scientific value of the indigenous theory and traditional methods of agriculture,

(*ii*) Veterinary research ?

(*b*) If in cases known to you progress is not being made because of the want of skilled workers, or field or laboratory facilities for study or by reason of any other handicaps, please give particulars. [Suggestions of a general kind should be made under (*a*) ; answers under this heading should relate to specific subjects. The purpose is to secure a list of the problems met with by scientific investigators in the course of their work which are being held over because of lack of resources or deficient organisation.]

(*c*) Can you suggest any particular subject for research not at present being investigated to which attention might usefully be turned ?

2. Agricultural Education.

With reference to any form of agricultural education of which you may have experience, please state your views on the following :—

(*i*) Is the supply of teachers and institutions sufficient ?

(*ii*) Is there an urgent need for extension of teaching facilities in any district or districts known to you personally ?

(*iii*) Should teachers in rural areas be drawn from the agricultural classes ?

(*iv*) Are the attendances at existing institutions as numerous as you would expect in present circumstances ; if not, state reasons. Can you suggest measures likely to stimulate the demand for instruction ?

(*v*) What are the main incentives which induce lads to study agriculture ?

(*vi*) Are pupils mainly drawn from the agricultural classes ?

(*vii*) Are there any modifications in existing courses of study which appear to be called for ; if so, what are they ?

(*viii*) What are your views upon (*a*) nature study ; (*b*) school plots ; (*c*) school farms ?

(*ix*) What are the careers of the majority of students who have studied agriculture ?

(*x*) How can agriculture be made attractive to middle class youths ?

(*xi*) Are there recent movements for improving the technical knowledge of students who have studied agriculture ?

(*xii*) How can adult education in rural tracts be popularised ?

(*xiii*) In suggesting any scheme for better educational facilities in rural areas, please give your views for (*a*) its administration and (*b*) its finance.

3. Demonstration and Propaganda.

(*a*) What are the measures which in your view have been successful in influencing and improving the practice of cultivators ?

(*b*) Can you make suggestions for increasing the effectiveness of field demonstrations ?

(*c*) Can you suggest methods whereby cultivators may be induced to adopt expert advice ?

(*d*) If you are aware of any striking instances of the success or the failure of demonstration and propaganda work, please give particulars and indicate the reasons for success or for failure.

4. Administration.

(*a*) Do you wish to suggest means towards the better co-ordination of the activities of the Governments in India or to indicate directions in which the Government of India may usefully supplement the activities of the local Governments ?

(*b*) Is it your opinion that the expert scientific knowledge required in the development of agriculture in the different Provinces could be supplied to a greater extent than is the case at present by increasing the scientific staff of the Government of India ? If so, indicate the types of work which would benefit by pooling the services of experts, and suggest how that work should be controlled.

(*c*) Are you satisfied from the agricultural standpoint with the services afforded by—

(*i*) The Agricultural and Veterinary Services.

(*ii*) Railways and steamers,

(*iii*) Roads,

(*iv*) Meteorological Department,

(*v*) Posts, and

(*vi*) Telegraphs, including wireless ?

If not, please indicate directions in which you think these Services might be improved or extended.

5. Finance.

(*a*) What are your views as to the steps that should be taken for the better financing of agricultural operations and for the provision of short and long-term credit to cultivators ?

(*b*) Do you wish to suggest means whereby cultivators may be induced to make fuller use of the Government system of *taccavi* ?

6. Agricultural Indebtedness.

(*a*) What in your opinion are :—

(*i*) the main causes of borrowing,

(*ii*) the sources of credit, and

(*iii*) the reasons preventing repayment.

(*b*) What measures in your opinion are necessary for lightening agriculture's burden of debt ? For example, should special measures be taken to deal with rural insolvency, to enforce the application of the Usurious Loans Act, or to facilitate the redemption of mortgages ?

(*c*) Should measures be taken to restrict or control the credit of cultivators such as limiting the right of mortgage and sale ? Should non-terminable mortgages be prohibited ?

7. Fragmentation of Holdings.

(*a*) Do you wish to suggest means for reducing the loss in agricultural efficiency attendant upon the excessive subdivision of holdings ?

(*b*) What are the obstacles in the way of consolidation and how can they be overcome ?

(*c*) Do you consider legislation to be necessary to deal with minors, widows with life interest, persons legally incapable, alienation and dissentients, and to keep disputes out of the courts ?

PART II

8. Irrigation.

(*a*) Name any district or districts in which you advocate the adoption of new irrigation schemes, or suggest extensions or improvements in the existing systems or methods of irrigation by—

(*i*) Perennial and non-perennial canals,
(*ii*) Tanks and ponds,
(*iii*) Wells.

What are the obstacles in your district or Province to the extension of irrigation by each of the above methods ?

(*b*) Are you satisfied with the existing methods of distributing canal water to cultivators ? Describe the methods that have been employed to prevent wastage of water by evaporation and by absorption in the soil. What form of outlet for distribution to cultivators at the tail end do you regard as the most equitable and economical ? Have these methods and devices been successful, or do you wish to suggest improvements ?

(*N.B.*—Irrigation charges are *not* within the terms of reference of the Commission, and should not be commented upon.)

9. Soils.

(*a*) Have you suggestions to make—

(*i*) for the improvement of soils, whether by drainage or other means, not dealt with under other headings in this questionnaire.
(*ii*) for the reclamation of Alkali (Usar) or other uncultivable land,
(*iii*) for the prevention of the erosion of the surface soil by flood water ?

(*b*) Can you give instances of soils known to you which, within your recollection, have—

(*i*) undergone marked improvement,
(*ii*) suffered marked deterioration ?

If so, please give full particulars.

(*c*) What measures should Government take to encourage the reclamation of areas of cultivable land which have gone out of cultivation ?

10. Fertilisers.

(*a*) In your opinion, could greater use be profitably made of natural manures or artificial fertilisers ? If so, please indicate the directions in which you think improvement possible.

(*b*) Can you suggest measures to prevent the fraudulent adulteration of fertilisers ?

(*c*) What methods would you employ to popularise new and improved fertilisers ?

(*d*) Mention any localities known to you in which a considerable increase in the use of manures has recently taken place.

(*e*) Has effect of manuring with phosphates, nitrates, sulphate of ammonia, and potash manures been sufficiently investigated ? If so, what is the result of such investigation ?

(*f*) What methods would you employ to discourage the practice of using cowdung as fuel ?

11. Crops.

(*a*) Please give your views on—

(*i*) the improvement of existing crops,

(*ii*) the introduction of new crops including fodder crops,

(*iii*) the distribution of seeds,

(*iv*) the prevention of damage by wild animals.

(*b*) Can you suggest any heavy yielding food crops in replacement of the present crops ?

(*c*) Any successful efforts in improving crops or substituting more profitable crops which have come under your own observation should be mentioned.

12. Cultivation.

Can you suggest improvements in—

(*i*) the existing system of tillage, or

(*ii*) the customary rotations or mixtures of the more important crops ?

13. Crop Protection, Internal and External.

Please give your views on—

(*i*) The efficacy and sufficiency of existing measures for protection of crops from external infection, pests and diseases.

(*ii*) The desirability of adopting internal measures against infection.

14. Implements.

(*a*) Have you any suggestion for the improvement of existing, or the introduction of new, agricultural implements and machinery ?

(*b*) What steps do you think may usefully be taken to hasten the adoption by the cultivator of improved implements ?

(*c*) Are there any difficulties which manufacturers have to contend with in the production of agricultural implements or their distribution for sale throughout the country ? If so, can you suggest means by which these difficulties may be removed ?

PART III

15. Veterinary.

(*a*) Should the Civil Veterinary Department be under the Director of Agriculture or should it be independent ?

(*b*) (*i*) Are dispensaries under the control of Local (District) Boards ? Does this system work well ?

(*ii*) Is the need for expansion being adequately met ?

(*iii*) Would you advocate the transfer of control to Provincial authority ?

(*c*) (*i*) Do agriculturists make full use of the veterinary dispensaries ? If not, can you suggest improvements to remedy this ?

(*ii*) Is full use made of touring dispensaries ?

(*d*) What are the obstacles met with in dealing with contagious diseases ? Do you advocate legislation dealing with notification, segregation, disposal of diseased carcases, compulsory inoculation of contacts and prohibition of the movement of animals exposed to infection ? Failing legislation, can you suggest other means of improving existing conditions ?

(*e*) Is there any difficulty in securing sufficient serum to meet the demand ?

(*f*) What are the obstacles in the way of popularising preventive inoculation ? Is any fee charged, and, if so, does this act as a deterrent ?

(*g*) Do you consider that the provision of further facilities for research into animal disease is desirable ?

If so, do you advocate that such further facilities should take the form of—

(*i*) an extension of the Muktesar Institute, or

(*ii*) the setting up, or extension of, Provincial Veterinary Research Institutions ?

(*h*) Do you recommend that special investigations should be conducted by—

(*i*) officers of the Muktesar Institute, or

(*ii*) research officers in the Provinces ?

(*i*) Do you recommend the appointment of a Superior Veterinary Officer with the Government of India ? What advantages do you expect would result from such an appointment ?

16. Animal Husbandry.

(*a*) Do you wish to make suggestions for—

(*i*) improving the breeds of livestock,

(*ii*) the betterment of the dairying industry,

(*iii*) improving existing practice in animal husbandry

(*b*) Comment on the following as causes of injury to cattle in your district—

(*i*) Overstocking of common pastures,

(*ii*) Absence of enclosed pastures, such as grass borders in tilled fields,

(*iii*) Insufficiency of dry fodder such as the straw of cereals or the stems and leaves of pulses,

(*iv*) Absence of green fodders in dry seasons,

(*v*) Absence of mineral constituents in fodder and feeding stuffs.

(*c*) Please mention the months of the year in which fodder shortage is most marked in your district. For how many weeks does scarcity of fodder usually exist ? After this period of scarcity ends how many weeks elapse before young growing cattle begin to thrive ?

(*d*) Can you suggest any practicable methods of improving or supplementing the fodder supply that would be applicable to your district ?

(*e*) How can landowners be induced to take a keener practical interest in these matters ?

Part IV

17. Agricultural Industries.

(*a*) Can you give any estimate of the number of days of work done by an average cultivator on his holding during the year ? What does he do in the slack season ?

(*b*) Can you suggest means for encouraging the adoption of subsidiary industries ? Can you suggest any new subsidiary industries to occupy the spare time of the family which could be established with Government aid ?

(*c*) What are the obstacles in the way of expansion of such industries as beekeeping, poultry rearing, fruit growing, sericulture, pisciculture, lac culture, rope making, basket making, etc. ?

(*d*) Do you think that Government should do more to establish industries connected with the preparation of agricultural produce for consumption, such as oil pressing, sugar making, cotton ginning, rice hulling, utilisation of wheat straw for card-board, utilisation of cotton seed for felt, fodder, oil and fuel, utilisation of rice straw for paper, etc. ?

(*e*) Could subsidiary employment be found by encouraging industrial concerns to move to rural areas ? Can you suggest methods ?

(*f*) Do you recommend a more intensive study of each rural industry in its technical, commercial and financial aspects, with a view to, among other things, introduction of improved tools and appliances ?

(*g*) Can you suggest any other measures which might lead to greater rural employment ?

(*h*) Can you suggest means whereby the people could be induced to devote their spare time to improving the health conditions of their own environment ?

18. Agricultural Labour.

(*a*) What measures, if any, should be taken to attract agricultural labour from areas in which there is a surplus to—

(*i*) areas under cultivation in which there is a shortage of such labour ? and

(*ii*) areas in which large tracts of cultivable land remain uncultivated ?

Please distinguish between suggestions designed to relieve seasonal unemployment and proposals for the permanent migration of agricultural population.

(*b*) If there is any shortage of agricultural labour in your Province, what are the causes thereof and how could they be removed ?

(*c*) Can you suggest measures designed to facilitate the occupation and development, by surplus agricultural labour, of areas not at present under cultivation ?

19. Forests.

(*a*) Do you consider that forest lands as such are at present being put to their fullest use for agricultural purposes ? For instance, are grazing facilities granted to the extent compatible with the proper preservation of forest areas ? If not, state the changes or developments in current practice which you consider advisable.

(*b*) Can you suggest means whereby the supply of firewood and fodder in rural areas may be increased ?

(*c*) Has deterioration of forests led to soil erosion ? What remedies would you suggest for erosion and damage from floods ?

(*d*) Can you indicate any methods by which supply of moisture in the soil, the rainfall and supply of canal water can be increased and regulated by afforestation or by the increased protection of forests so as to benefit agriculture ? Would the same methods be useful in preventing the destruction by erosion of agricultural land ?

(*e*) Is there an opening for schemes of afforestation in the neighbourhood of villages ?

(*f*) Are forests suffering deterioration from excessive grazing ? Is soil erosion being thereby facilitated ? Suggest remedies.

20. Marketing.

(*a*) Do you consider existing market facilities to be satisfactory ? Please specify and criticise the markets to which you refer, and make suggestions for their improvement.

(*b*) Are you satisfied with the existing system of marketing and distribution ? If not, please indicate the produce to which you refer and describe and criticise in detail the channels of marketing and distribution from the producer to the consumer in India (or exporter in the case of produce exported overseas). State the services rendered by each intermediary and whether such intermediary acts in the capacity of merchant or commission agent, and comment upon the efficiency of these services and the margins upon which such intermediaries operate. Please describe

the method by which each transaction is financed, or in the case of barter, by which an exchange is effected.

(*c*) Do you wish to suggest steps whereby the quality, purity, grading or packing of agricultural produce may be improved, distinguishing where possible between produce destined for—

(*i*) Indian markets ?

(*ii*) Export markets ?

(*d*) Do you think that more effective steps might be taken to place at the disposal of cultivators, merchants and traders information as to market conditions, whether Indian or overseas ; crop returns ; complaints as to Indian produce from wheresoever originating ; and agricultural and marketing news in general ?

21. Tariffs and Sea Freights.

Do existing (*a*) customs duties, both import and export, and (*b*) sea freights adversely affect the prosperity of the Indian cultivator ? If so, have you any recommendations to make ?

22. Co-operation.

(*a*) What steps do you think should be taken to encourage the growth of the co-operative movement—

(*i*) by Government,

(*ii*) by non-official agencies ?

(*b*) Have you any observations to make upon—

(*i*) Credit societies ;

(*ii*) Purchase societies ;

(*iii*) Societies formed for the sale of produce or stock ;

(*iv*) Societies for effecting improvements—*e.g.*, the digging of wells and the construction of bunds, walls and fences, or the planting of hedges ;

(*v*) Societies formed for the aggregation of fragmented holdings and their redistribution in plots of reasonable size ;

(*vi*) Societies for the co-operative use of agricultural machinery ;

(*vii*) Societies for joint farming ;

(*viii*) Cattle breeding societies ;

(*ix*) Societies formed for any purpose connected with agriculture or with the betterment of village life, but not specified above ?

(*c*) Where co-operative schemes for joint improvement, such as co-operative irrigation or co-operative fencing or a co-operative consolidation of holdings scheme, cannot be given effect to owing to the unwillingness of a small minority to join, do you think legislation should be introduced in order to compel such persons to join for the common benefit of all ?

(*d*) Do you consider that those societies of which you have personal knowledge have, in the main, achieved their object ?

23. General Education.

(*a*) Do you wish to make observations upon existing systems of education in their bearing upon the agricultural efficiency of the people ? If you make suggestions, please distinguish, as far as possible, between—

(*i*) Higher or collegiate,

(*ii*) Middle school, and

(*iii*) Elementary school education.

(*b*) (*i*) Can you suggest any methods whereby rural education may improve the ability and culture of agriculturists of all grades while retaining their interest in the land ?

(*ii*) What is your experience of compulsory education in rural areas ?

(*iii*) What is the explanation of the small proportion of boys in rural primary schools who pass through the fourth class ?

24. Attracting Capital.

(*a*) What steps are necessary in order to induce a larger number of men of capital and enterprise to take to agriculture ?

(*b*) What are the factors tending to discourage owners of agricultural land from carrying out improvements ?

25. Welfare of Rural Population.

(*a*) Outside the subjects enumerated above, have you any suggestions to offer for improving hygiene in rural areas and for the promotion of the general well-being and prosperity of the rural population ?

(*b*) Are you, for instance, in favour of Government conducting economic surveys in typical villages with a view to ascertaining the economic position of the cultivators ? If so, what, in your opinion, should be the scope and methods of such enquiries ?

(*c*) If you have carried out anything in the nature of such intensive enquiry, please state the broad conclusions which you reached.

26. Statistics.

(*a*) Do you wish to make suggestions for the extension or improvement of the existing methods of—

(*i*) ascertaining areas under cultivation and crops ;

(*ii*) estimating the yield of agricultural produce ;

(*iii*) enumerating livestock and implements ;

(*iv*) collecting information on land tenure, the incidence of land revenue and the size of the agricultural population ;

(*v*) arranging and publishing agricultural statistics ?

(*b*) Have you any other suggestions to make under this heading ?

MINUTES OF EVIDENCE

TAKEN BEFORE THE

ROYAL COMMISSION ON AGRICULTURE.

Tuesday, November 9th, 1926.

BANGALORE.

Present:

The MARQUESS OF LINLITHGOW, D.L. (*Chairman*).

Sir HENRY STAVELEY LAWRENCE, K.C.S.I., I.C.S.
Sir THOMAS MIDDLETON, K.B.E., C.B.
Rai Bahadur Sir GANGA RAM, Kt., C.I.E., M.V.O.
Sir JAMES MACKENNA, Kt., C.I.E., I.C.S.
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Professor N. GANGULEE.
Dr. L. K. HYDER.
Mr. B. S. KAMAT.

Mr. J. A. MADAN, I.C.S.
Mr. F. W. H. SMITH. } (*Joint Secretaries.*)

Mr. W. SMITH, Imperial Dairy Expert, Bangalore.

Memorandum on the Animal Husbandry Section, Bangalore.

In submitting memoranda to a Commission some of the members of which are not intimately acquainted with Indian agricultural conditions, it is necessary in the first place to briefly state the present position of the cattle-breeding and dairy industry and its importance from the point of view of the agricultural well-being of the country.

This Section of the Imperial Agricultural Department which is under my control deals primarily with dairying and dairying means cattle-breeding and connotes the whole cattle industry. India, speaking in a general sense, does not rear cattle for beef and consequently milch cattle and plough bullocks are her cattle requirements, and as it takes a cow to produce a bullock and as the country cannot afford to have any cows which are not milk-producing cows, it follows that the dairy industry includes the whole cattle-breeding industry; the two are one and indivisible. The development of the dairy and cattle-breeding industry is by a long way the most important agricultural

problem in India. The Indian agriculturist has more of his money invested in cattle than in any other capital form. It is more important than the growing of wheat or cotton or rice or any crop; it is as important and universal as the growing of all crops. India is a country of small fragmented holdings and the cultivation of the land cannot be done by tractors or by horses or mules, it can only be done so far as traction is concerned by the agency of the bullock so that the cultivation of every crop depends upon the efficiency of the working bullock, not only so but the primary transport of all crops produced must be done by the bullock. There is no doubt whatever but that the use of improved implements and machines for the cultivation and harvesting of crops has been and is being seriously retarded, because the cultivator does not possess a bullock of sufficient strength, size, weight or speed to work these improved machines and implements. The health and physical welfare of the whole of the people of India depends upon a plentiful, pure and clean supply of dairy produce. Great masses of the people of this country are vegetarians and I think it is admitted nowadays that in no form of vegetable fats can that particular growth principle be found which is so necessary for the proper development of the young. This growth element can only be found in animal fat, and as our people in the main do not eat flesh the only kind of animal fat they can use to attain the growth vitamines is milk fat. The milk-supply of India to-day is indescribably bad; it is filthy, expensive and scarce. No wonder the infant mortality in some of our large cities equals 666 per 1,000 infants from birth to one year old.

The cattle-breeding and dairy industry is also important because in its present state it imposes a colossal yearly drain on the wealth of the country. In India including Indian States there are at the present time 180,000,000 of all kinds of bovine stock, the total value of which may be taken as some nine hundred crores (nine thousand millions) of rupees. The majority of the people of India are Hindus and to the Hindus it is wrong to take animal life, not only so but it is a doubly heinous offence to take the life of any member of the ox tribe. The cow is sacred and is venerated by the Hindus from Peshawar to Tuticorin. Broadly speaking, the cattle-breeding industry in India is in the hands of ignorant jungly tribes who have no scientific knowledge of the principles of breeding or the practice of cattle-rearing, and consequently millions of absolutely useless scrub cattle are born in the country every year. These animals are so poor that they cannot do any work nor do the females yield any milk, yet having been born they cannot owing to the Hindu sentiment be killed and the country must keep them until they die. These animals not only yield the country no return outside of the value of their hide and bones when they die, but they consume the food which the working and milk-producing animal ought to get and as the males are not castrated they perpetuate their degenerate species all over the land. In any other country in the world these animals would be killed and utilised for food at the end of their third monsoon when they had sufficient flesh on their bones to pay for what they had eaten. Here they have a brief period of plentiful feeding each monsoon, followed by eight or more months of semi-starvation until they die, and their bones and hides are sold by the sweeper caste. A writer in the "*Madras Mail*" of 21st April, 1926, calculates that the loss to this country due to the upkeep of these useless cattle is not less than sixty-one crores and twenty lacs (six hundred and twelve millions) of rupees per annum. I cannot vouch for the correctness of this figure, but the drain on the wealth of the country due to this state of affairs is truly colossal and the foregoing shows the existing deplorable state of the cattle-breeding and dairy industry. It will be seen then that not only is the development of the cattle-dairy industry the most important problem facing Indian agriculture, but owing to the Hindu sentiment "thou shalt not kill the cow" it is the most difficult agricultural problem in India. The improvement of the quality of Indian crops or methods of Indian cultivation, and the education of the Indian cultivator are as easy here as they are in any other part of the world, but the cattle problem is hedged around by Hindu sentiment, and by reason of this sentiment it is not only the loss through the working and milking of inefficient cattle that India has to face, she has to

foot a larger bill in supporting the altogether useless cattle which cannot be killed owing to the sentiments of her people. There is only one solution of the problem. Hindu sentiment will not change for a long time to come and the cattle-breeding and dairy industry must be raised to that high level of efficiency when the breeders of cattle will only permit efficient and suitable animals to be born and those only in such numbers as the country requires. Now not only is the cattle-breeding and dairy question the most important and the most difficult problem facing the Indian agriculturist, but it is the most universal. It must be handled from an All-India point of view. It cannot adequately be dealt with by Provinces or States, because the cattle-breeding policy and practice of one Province or State may largely affect the agricultural efficiency of another Province or State. Bengal, for instance, breeds comparatively few cattle and those she does breed are of poor quality. The Bengali cultivator to a large extent depends upon the breeders of Bihar and Orissa to supply him with his work cattle. Then again both Rangoon and Calcutta depend almost entirely on the Punjab for the supply of their milch cattle and Bombay draws its milking cattle from the Punjab and Sind. Not only is the question universal from this point of view, but over the whole country every caste, creed, and class uses milk and milk products freely in their dietary and cultivators of every part of India look for an efficient field ox. It would seem, therefore, that this question which is so vital to the agricultural and general progress of the country would receive very special attention at the hands of the Central Government. That it has not done so can be easily proved. In fact this great problem has been all along treated as the Cinderella of Imperial Agriculture as the following brief resume of facts will show.

In response to recommendations made by the Board of Agriculture at their meetings at Coimbatore in 1913 and Pusa in 1916 the Government of India in May 1920 appointed an Imperial Dairy Expert, and in July 1921 the appointment of a Physiological Chemist was made to carry out research work in connection with problems of animal nutrition. The recommendation made by the Board of Agriculture at the two meetings before referred to, besides the appointment of an Imperial Dairy Expert and a Physiological Chemist, recommended the establishment of dairy schools and of breeding farms on a moderate scale; but although I was appointed to the post of Imperial Dairy Expert in May, 1920, Government did not provide me with either money or facilities of any sort whatever to carry out any educational or research work until July 1923. In 1922, with the enthusiastic support of the Agricultural Adviser to Government, I requested Government to hand over to this department the thirty-four Military dairy farms in India so that they could be utilised as training centres, breeding farms and research stations. On the recommendation of the Inchcape Committee two of these farms with a small hill farm were handed over for educational and research purposes instead of thirty four asked for, and the farms handed over were only given on the understanding that they were to be self-supporting, or in other words that this department would provide that education so badly wanted, and carry out as well much needed research work without a penny of cost to the State.

The farms before referred to, which were taken over from the Military Department in 1923, are situated at Karnal in the Punjab and Bangalore or Mysore State with a branch of Bangalore farm at Wellington in the Nilgiri Hills. Then, in October, 1925, this department took over the Military creamery at Anand in Gujarat to be used, as a dairy factory school. The staff employed by the Military Department on the Bangalore, Wellington and Karnal farms were taken over with the farms. The laboratories of the Physiological Chemist to Government were moved from Pusa and the Bangalore farm was converted into a central teaching and research institution now known as the Imperial Institute of Animal Husbandry and Dairying. Three classes of pupils are taken on there for training from all parts of India, *viz.*:—

(1) Post-graduate pupils for advanced instruction in animal nutrition, animal husbandry and dairying.

(2) Pupils for the Indian dairy diploma granted by the Institute (2 years' course).

(3) Short course students for special instruction in specific subjects connected with animal husbandry or dairying.

The Karnal farm is utilised for the instruction of all three of the above classes of pupils and is primarily a cattle-breeding research station where three separate herds of pure Indian cattle have been established and which are being developed on pure lines.

The Wellington farm is merely a branch of Bangalore kept up to provide the British garrison in that station with pure milk and butter.

The Anand Creamery was acquired in order to provide factory instruction and to carry out research work in connection with the manufacture of *ghi*, butter, condensed milk, dried milk and factory milk products generally. I have just learned that Government may close down this factory because it is not paying. This creamery is situated in the one district in India where milk is available in large quantities, and where butter and casein are manufactured for home consumption and export. This Section cannot possibly carry out its work without one dairy factory of this kind. Indian factory methods of butter, *ghi*, and casein manufacture are crude, uneconomical and dirty. India imports large quantities of condensed milk, dried milk, and milk products of various kinds, all of which should be made in the country. Research and experiment of this kind is more necessary in India at the present moment than any other class of dairy work. In fact it is absolutely vital to India. It lies at the root of the whole cattle problem. It is no use improving the yield of the Indian cow or buffalo unless along with this improvement a market is provided for the milk of these animals. This can only be done in the rural areas by developing the manufacture of milk products. Nothing whatever is known about the scientific manufacture of any class of modern milk product from the milk of the buffalo. Present methods are crude, filthy and wasteful. The closing down of the research creamery at Anand would be a national disaster. The most urgent and pressing dairy problem in India to-day is the utilisation of by-products in the manufacture of *ghi*, and so far neither the Imperial nor any Provincial Government has touched the problem. This Section was preparing to do so at Anand.

So far outside of the actual staffs required to work the farms and formerly employed by the Military dairies no extra staff for educational and research work has been provided for this Section other than that a general assistant to the Imperial Dairy Expert was appointed in December 1925. Consequently the amount of research work undertaken has not been at all commensurate with the needs of the industry. The demand for dairy and cattle-breeding education at all the farms and the dairy factory has since the commencement of the concerns been far more than could be undertaken. Research work in the development of our two herds of Indian cows and the Indian buffalo herd at Karnal (the former on dual purpose lines, milk and draught, and the latter for milk production) is being caried out. Owing to paucity of staff and want of funds this Section has not yet been able to touch the fringe of the many pressing problems facing the cattle-breeding and dairy industry in its national aspect, consequently practically no results of research work done by this Section have so far been made available for the advancement of Indian agriculture.

Since my appointment as Imperial Dairy Expert in 1920 this Section has been in continual close touch with all the Provincial Departments of Agriculture, with the Corporations of the large cities and with most of the Indian States, *pinjrapole* societies, etc., and technical advice with building plans, machinery specification, etc., has issued from my office in a continuous stream since its inspection. The demand from all over the country for this class of information continues to increase and the supply of technical advice occupies a large part of my time and that of my assistant. I maintain a practically continuous correspondence with all the Directors of Agriculture in India, with

many of the Co-operative Departments and with the cattle-breeding experts. My office is freely consulted by all the Departments of Agriculture in the country on matters connected with cattle-breeding and dairying, and in this respect I consider we have done, and are doing good work.

The training of post-graduate students at Karnal, Anand and Bangalore for the highest posts of the department is undertaken by this Section in co-operation with the Physiological Chemist to Government; and in my opinion this training could be improved by the provision of a scientific research staff at Bangalore and Karnal farms, but especially at the Anand Creamery under whom the post-graduate men could work.

I consider that our present facilities for giving short courses of study to persons connected with the cattle-breeding and dairying industry are good, but they would be improved by the addition of the scientific research staff above referred to.

The work of this Section has been carried on at all times in the most active and pleasant co-operation with all the officers of the Imperial Agricultural Department and as before stated with the Directors of Agriculture and expert cattle-breeding dairy officers of all the Agricultural and Veterinary Departments. This Section by reason of the class of work done has been more particularly in touch with the Agricultural and Bacteriological Sections at Pusa and in daily co-operation with the Physiological Chemist at Bangalore. On various occasions the Section has supplied detailed information regarding the position of the dairy industry in India to the International Institute of Agriculture in Rome.

Replies to the Questionnaire.

Before dealing with those specific questions which pertain to cattle-breeding and dairying, I desire to make a few remarks regarding Question I (*b*), Research.

QUESTION 1 (*b*).—The section of the Imperial Department of Agriculture under my control comprises the following units in addition to the office of the Imperial Dairy Expert:—

The Imperial Institute of Animal Husbandry and Dairying, Bangalore.

The Imperial Government Dairy Farm at Wellington.

The Imperial Government Cattle Breeding Farm at Karnal, Punjab

The Imperial Government Creamery at Anand, Gujarat.

The office of the Imperial Dairy Expert was opened in May 1920, and the three first mentioned farms were taken over from the Military in 1923. The Anand Creamery was taken over in 1925.

All of these institutions are utilised as far as circumstances permit as teaching or research centres. The Imperial Institute of Animal Husbandry and Dairying grants a diploma in practical dairy farm management. The course for this diploma is a two years one, and the teaching for this diploma, in order to make it as varied and practical as possible, is given at Bangalore, Karnal and Anand Creamery. The number of students now under training for this diploma is 23 this being the maximum number which the existing hostel accommodation could provide for, but the actual number of suitable men who applied for tuition in the class now undergoing instruction was 69. In addition to the diploma students all the farms under this section and the creamery take men for short technical courses, as well as post-graduate students for special research work. During the past two years 74 short course students and 7 post-graduate students have taken courses.

The laboratory, cattle sheds and stores of the Physiological Chemist to Government are situated in the farm yard of the Bangalore Institute, and the scientific staff of this officer has up to the present very kindly undertaken the teaching of students in dairy chemistry, food analysis, and animal nutrition. I regard the animal nutrition work of the Physiological Chemist as of vital importance to the agriculture of India, and it has been the aim of this office to co-operate with him in every possible direction, but if the activities of this officer are to expand in the future as they have in the past the day is not far distant when there will not be room at the Bangalore farm for the Institute and the Physiological Chemist, and I am of opinion that in view of the magnitude and national importance of animal nutrition research a separate farm with herd, lands and scientific laboratories should be given to the Physiological Chemist, and that the existing laboratories and buildings now occupied by him at Bangalore be handed over to the dairy institute and utilised for teaching and research purposes on cattle-breeding and dairy problems. This eventuality was foreseen in 1924, as in that year this office suggested to the Government of India that the Hosur Remount Depôt, now the Madras Government Cattle Farm, then the property of the Imperial Government which was to be abandoned by Military Remount Department, should be handed over to the Bangalore Institute in order to permit of future extensions and to enable the Bangalore farm to grow its own fodder requirements. Up to the present this Section has been able to do very little in the direction of research work in connection with dairy problems. Experimental cattle-breeding work is being done at all three farms, but owing to lack of staff and funds, and to the fact that in the initial stages the energies of this office were concentrated upon the organisation of the farms as educational centres, little or nothing has been done to solve the many pressing problems affecting the dairying and cattle-breeding industry. The time has now come when this work should be undertaken on a purely national scale. In this connection please see my remarks on page 10 of this note regarding Anand Creamery. On the purely

dairy side of the work the factory problems there referred to are most pressing. The following specific problems, I consider, call for immediate investigation:—

(1) The manufacture, storage and transport of *ghi*.

(2) The manufacture of condensed milk from the milk of the buffalo.

(3) The utilisation of the skim or butter milk a by-product from *ghi* manufacture, connoting the manufacture of dried milk, casein, milk sugar, skim milk cheese.

(4) The manufacture, storage and transport of butter under tropical conditions.

(5) Standardisation of Indian dairy products as regards purity.

(6) Testing and recording of the quality, *i.e.* chemical composition, of the milk of all the different well-known breeds of Indian cows and buffaloes.

(7) Transport of fresh milk for long distances in India including transport methods.

QUESTION 16 (*a*).—For two reasons it is vitally important that something should be done on a national scale to improve the breeds of cattle in India. Firstly the quality of the cattle of India grows worse from year to year. The introduction of modern and more efficient cultivating, seeding and harvesting machinery is being retarded, and the growing of every class of crop is adversely affected through the inefficiency of the plough bullock. Not only so but the general health and physical well-being of the whole community, rural as well as urban, is detrimentally influenced through the lack of a plentiful, cheap and safe supply of dairy produce, due to the inefficiency of the Indian milch cow.

Secondly owing to the Hindu sentiment regarding the killing of cattle and to the ignorance, apathy and want of skill on the part of the cattle breeders, this country is called upon to support continually millions of cattle which, from birth to death, are quite useless. They are not good enough to do any work or produce any milk. It costs the country anything from Rs. 15 to Rs. 30 per head per year to keep them. Their average life may be taken as 6 years and at the end of that time they die and the country gets Rs. 12 to Rs. 15 per head for their skin, horns and bones. Not only so but these perfectly useless animals eat up the fodder which should go to the fairly efficient workers and milkers, and thereby impair their utility. Again in the districts which support these animals, castration is not generally practised and the miserable half starved males roam about perpetuating their species and further reducing the quality of the cattle of the country. It is difficult to estimate how much this drain on the wealth of India amounts to. That it reaches a colossal figure yearly is certain.

Cattle-breeding and dairying in India, I regard as one and indivisible. This is mainly a vegetarian country and beef has no value, nor will the people of India work the female of the ox tribe in the plough or the cart, so that what the country wants is efficient draught bullocks and profitable milking cows. It being particularly borne in mind that almost every animal born must be permitted to live and must be fed. We cannot destroy the poor field worker nor the worthless cow. The country is saddled with whatever its cows give birth to, and it cannot afford to keep a cow just good enough to be the dam of future generations. In order that the cow shall pay for her keep she must, seeing she is prevented by custom from doing field work, give sufficient milk to rear her calf and in addition as much as will be equal in value to the cost of her maintenance. For India therefore we require for all districts a suitable type of dual purpose animal, the male being efficient as a field worker and the female as a milker. It has, I think, been demonstrated now that such cattle are obtainable and that many of the best breeds we have in India, possess these dual qualities.

Mr. W. Smith.

If the foregoing accurately describes the position then the solution lies in:—

(1) The development of pedigree herds on dual purpose lines, suitable for each district.

(2) The careful distribution and supervision of bulls from these herds.

(3) The development simultaneously with (1) and (2) of technical dairying and especially the co-operative handling and sale of milk, production and sale of *ghi*, and manufacture and sale of milk products, all as village industries.

(4) The dissemination of knowledge regarding the breeding, rearing and feeding of cattle and the growing and conservation of fodder crops for their maintenance.

(5) The extension of the Civil Veterinary Department to give better service in the detection, prevention and cure of animal diseases.

With regard to (1) the formation of pedigree herds. My experience in India follows that of the world of animal breeders in general that successful breeding cannot be done with a mongrel sire. There was probably a day in the history of India when the dedicated or Brahmini bulls, used mainly for breeding purposes throughout the country were the best that could be procured. At that time huge more or less isolated ranching areas were available for cattle-breeding where there was little or no admixture with different types of cattle from other parts of the country, but the spread of irrigation canals, the reservation of forests, and the general increase of the cultivated area has driven the cattle-breeding clans into the rough jungle tracts, and the improvement of roads, the establishment of railways and the general advance in transport and means of communications, has so mixed up the one time breeds of cattle in India, that most of the bulls now used as sires can be truly classed as mongrels. Added to this is the fact that in India as in other parts of the world, religious fervency has declined and the Brahmin, who now dedicates a bull on the birth of his son, is often more concerned in obtaining an animal at a moderate price than with getting the best possible breeding bull. In this connection please see copy of this office letter No. 2925-A., dated 6th January 1926 (Appendix I), addressed to the All-India Cow Protection Society. The pedigree herds of cattle in Great Britain, which have formed the foundation stock of more than half the cattle in the world's temperate zones, were built up by private individuals and the various now well-known breeds were evolved or created at the expense of private enterprise, and it has been stated that the same procedure must be followed in India. I give it as my opinion that this cannot be done here and if India is to wait until her private cattle owners, at their own expense, build up pedigree breeds of cattle, she will wait until the crack of doom. The conditions are very different. In Europe the commercial value of beef enabled the far-sighted breeder to dispose off his rejections, which in the initial stages must be numerous, at an economic figure and he could knock on the head at birth any very weedy calves. In India the flesh of cattle has little or no value as food and if it had, no self-respecting Hindu breeder would sell his cattle to a butcher nor will he kill worthless calves. The building up of pedigree herds in India must be a losing business for many years to come and therefore it can only be done by the State. No amount of propaganda or official persuasion will induce Indian landed proprietors, cultivators or business men to undertake this work because although it will in time yield a handsome return to the country in the increase of wealth due to enhanced cattle efficiency yet, the loss or cost to the person, company or State which does this pioneer work will be heavy. Government cattle-breeding farms in India cannot be expected to pay their way for many years to come and this fact has been emphasised by the Board of Agriculture.

Regarding the second recommendation of this note—the distribution and control of pedigree bulls. This is a work which will require very special attention. It may be done through local boards, village panchayets, co-operative societies or other agencies, and along with this must go an organised

system for the castration of all unfit males. Bearing in mind the fact that in most parts of India cattle once born cannot be killed or sold for beef, it will be realised how important it is that only the number of cattle actually required by the country should be begotten and only efficient and healthy animals should be brought into world. We have far too many cattle in India. What we want is fewer cattle, but all of them efficient and profitable. The aim of the Agricultural Departments from a breeding point of view should be suitable bull or bulls in every village, properly controlled and supervised. This is not an impossible dream. It has already been done in some parts of the Punjab where owing to the energetic action of the Government of that Province, the decline in the quality of cattle has been stayed.

We are at the parting of the ways in India in regard to this cattle-breeding problem. This country like all other countries at some stage of their development, has reached the point where it can no longer afford to set aside huge areas for breeding cattle on the ranching system, because it now requires these areas to grow food for its people and cotton to clothe them. Owing to want of knowledge on the part of those closely interested in stock breeding, the cattle of the country have got into such a mixed up condition that it is not profitable for the cultivator to breed his own animals. It must therefore be the aim of all interested in agricultural propaganda and progress to demonstrate to the cultivator that he must breed and rear cattle and that if he uses the right breeds and practises the correct methods, cattle-rearing and the growing and conserving of fodder crops for this purpose as a regular part of his agricultural operations will be profitable. There is no use telling the cultivator this. It must be demonstrated to him before his eyes, and it cannot be demonstrated until he can be offered the services of a bull which will be certain under specific condition to produce an efficient field bullock and a profitable milch cow, and it is at this juncture that the third proposal of this note (the development of technical dairying) comes in. It is not merely necessary to enable the cultivator, who must be the breeder of the future, to produce a milk-yielding cow. He must be taught how to economically utilise the milk of this animal. The milk producers of India to-day are steeped in technical ignorance and superstition. The methods of manufacture of *ghi* and the various forms of Indian cheese and partially evaporated milk are filthy and wasteful, so much so that at the flush season of the year in many of the *ghi*-producing tracts the butter milk or by-product from *ghi* manufacture containing all the valuable casein albuminoids and milk sugar is thrown away. Apart from this aspect of the question, India badly requires village industries to provide additional sources of employment and to generally increase the standard of village life. What industries are more suitable for this purpose than the manufacture of *ghi*, country cheese, casein and dried milk, etc., on a small factory scale owned and managed on co-operative principles. With the aim of encouraging this phase of dairy development, I started a class for the instruction of officers of the Co-operative Departments of all the Provincial Governments and Indian States, at the Imperial Institute of Animal Husbandry and Dairying at Bangalore. The first class held in 1925 was attended by some 26 officers from most of the Provinces and principal Indian States. The Government of India authorised this class but in doing so they gave it as their opinion that in giving instruction of this nature the Imperial Department of Agriculture were encouraging on the functions of the Provincial Departments of Agriculture. I attach copy of a letter from the Registrar of Co-operative Societies, Punjab, to the Government of India and a copy of the reply of the Government of India to the same (Appendix II), from which it will be seen that the Government of India expect a recommendation from the Royal Commission on Agriculture regarding this matter and the Royal Commission on Agriculture may consider the advisability of communicating their views to the Government of India at a date earlier than the submission of their full report.

Up to the present none of the agricultural colleges in India has attempted to give instruction in dairy factory work nor has any experimental work been done on the very important problems such as the manufacture of *ghi*,

casein, or other milk factory products. In October last the dairy section of the Imperial Department of Agriculture took over the disused Military Creamery at Anand in Gujarat, for the purpose of utilising it as an instructional centre for creamery work and for experimental work in connection with dairy factory problems. The working of this creamery has not, owing to severe competition in the fresh butter market and for other reasons, been as profitable commercially as I had hoped and consequently the Government of India, I understand, contemplate closing it down. In this connection I attach copy of a letter addressed to the Agricultural Adviser to Government, on June 16th, 1926 (Appendix III) and with a view to advising the Government of India concerning the retention or otherwise of this creamery, the Royal Commission on Agriculture might consider the advisability of some of its Members visiting this creamery and inspecting the local butter and *ghi* factories in Gujarat, the greatest milk-producing district in India. As an indication of the conditions now prevailing in the Gujarat dairies, I may mention that the Bombay Cattle Commission which consisted of 5 distinguished Indians and 2 Europeans described these places in paragraph 31 of their report published in 1923 as reproduced below: —

"The Committee whilst touring in Gujarat took the opportunity of visiting some of the so called dairies in Ahmedabad where the bulk of the butter and other dairy produce is manufactured for the whole of India. The Committee were surprised to find that this industry is carried out under the most filthy and dirty conditions imaginable. These so called "dairies" are situated in the most insanitary by-lanes of the city. The butter produced under these conditions is sold all over India and a certain amount is exported (even to Great Britain). It is a well-known fact that milk and its products are best medium possible in which injurious bacteria and germs of typhoid, diptheria, cholera, etc., thrive and in which they are carried and spread over the whole of India. It is essential for the public health that production on honest and scientific lines should be made a financial success, so that the public at large will get a safe and sure supply of milk and its several products."

Owing to lack of funds and the attempt to obtain commercial results from what are educational and research institutions, no research work has yet been done in connection with such pressing problems as: —

(*a*) the manufacture, storage and marketing of *ghi* in large and small quantities;

(*b*) the manufacture of casein, condensed milk or dried milk from buffaloes milk;

(*c*) manufacture of *panir* (Indian cheese) from skim-milk.

This kind of research work can only be properly carried out at an experimental dairy factory situated in the premier milk-producing area, Gujarat. It is useless to attempt this class of experiment with milk produced by Government cattle fed, housed, and looked after under perfect conditions at the Government owned farms at Bangalore and Karnal. This work must be done on a factory scale with purchased village milk produced under ordinary working conditions and adulterated, as the village producer will insist on adulterating it. Within the last 20 years India has lost the valuable butter export trade to the Far East because of the inferior quality of her butter due to lack of technical knowledge of methods of manufacture. For the same reason the value of Gujarat casein in the world's markets is only half of the French and New Zealand product. The site of the Anand Creamery is most suitable, the land on which the creamery stands is already the property of the Imperial Government, and the closing of this creamery before it has even begun its much needed research work would, I think, (as I have stated in my letter to the Agricultural Adviser to the Government of India) be nothing short of a national calamity. In this instance also, and in view of the urgency of the question, the Royal Commission may consider the advisability of communicating with the Government of India at an early date.

The cultivator in India knows how to make use of his bullock, but he does not possess the most elementary knowledge of how to make profitable use of the surplus milk from his cows or buffaloes. Along with the improvement of quality of his cow he must be taught how to utilise his milk to the best advantage.

In dealing with the fourth recommendation of this note it is unnecessary to say much. Vigorous propaganda by means of cinema films, lantern slides, lectures and last but not least small demonstration farms, where profitable cattle are employed and where the benefits of mixed farming with stock breeding as an essential part, could be shown in operation.

As regards item five of the recommendations of this note, I regard the work of cattle-breeding, rearing, feeding and management as coming under the sphere of agriculture rather than veterinary operations. There is so much scope for the skilled veterinary officer in the sphere of the prevention and cure of animal diseases that I consider he cannot profitably be asked at this juncture to take up such purely agricultural problems as the breeding and rearing of livestock.

Before dealing with the minor points raised in the Questionnaire, I desire to call attention to the national aspect of this cattle-breeding question and the necessity for some form of central authority for dealing with it. The Board of Agriculture recognising this have at their meetings at Bangalore in 1924 and at Pusa in December 1925 recommended the establishment of a Central Cattle Bureau. This has been commenced with a small clerical staff and the Imperial Dairy Expert as Secretary and it is understood that the Government of India have under consideration the formation of a representative board or committee, as recommended by the Board of Agriculture at their Pusa meeting in 1925, to control the operations of the Central Cattle Bureau. The functions of this Bureau under the control of a Committee represented of all the Provincial Governments and Indian States would be to establish and control herd books, to supervise and authenticate milk records, to keep all Governments and breeders in touch with the cattle-breeding activities of other breeders; and the Bureau, if given sufficient staff and funds, will do a useful and very necessary work in India, but the cattle-breeding dairying problem is so universal to the whole country and so important nationally that I consider some greater degree of central co-ordination and guidance is necessary than can be exercised by the Central Cattle Bureau. It is I think certain that Bengal, by reason of the nature of its soil and climate, will always require new blood for cattle-breeding from other Provinces of India. Calcutta at present procures the whole of its milch cattle from the United Provinces and the Punjab. Bombay is largely dependent for its supply of milch cattle on the Punjab. The Province of Sind supplies milch cattle to many districts in India and Burma, and Rangoon imports cattle regularly from the Punjab and Bihar. Then there is the question of control of the export and import of cattle which must always be in the hands of the Government of India. The time is perhaps not yet ripe for the restriction of the movements of cattle to prevent the spread of disease, but this will come some day and when it does it will have to be controlled by the Central Government. The question of milk standards standards of purity for *ghi*, butter and other dairy products, should be the same all over the country and generally speaking this cattle-breeding dairying question is so universal, its development so vital to the whole country that if at all possible the Government of India should retain some sort of central control over it. This might best be done by the Central Government giving substantial grants to Provincial Governments for cattle-breeding dairying, conditional on the money being spent on work approved of by the Central Government, or if the control of the Government of India was objected to the central authority might take the form of a central agricultural council representative of all the Provincial Governments and Indian States with small executive committees of experts to deal with each of the special phases of agriculture in the country.

QUESTION 16 (*b*).—My district is the whole of India and Burma, and consequently in this note I have attempted to deal with the whole question from a

national as opposed to a provincial point of view. In most cases what remains of the common pastures are overstocked, and they will be so until the cultivator becomes a breeder and until he realises that he can make money by breeding and rearing cattle and growing and conserving fodder for this purpose. He will only be able to do this with some degree of assistance from the State in the direction of:—

(*a*) The provision and control of suitable sires.

(*b*) Education, by demonstration and otherwise concerning breeding and rearing of cattle and the utilisation and sale of dairy produce.

After all every country in the world which has tackled the improvement of its cattle has employed some system of *State aided* bull provision and distribution. In the more developed countries the premium bull system is in operation to-day. Here we must produce the pedigree bull to commence with as he is not otherwise available. It is the recognised function of every State to provide not only elementary education but technical education for its people. Dairying on village factory lines has greatly added to the wealth of all the most progressive nations of the world, and India cannot afford to refuse technical education on this subject.

Grazing on the cultivated tracts and especially the irrigated tracts in India is a waste of land. What the Americans term "siloin" is the most economical way of feeding cattle, outside of the jungle tracts, in India. This question will only be solved when it can be made profitable for the cultivator to rear cattle and to grow and conserve the necessary fodder for their maintenance. At the same time much could be done all over India by the conservation of the surplus green grasses of the coarser types, during the rains, by means of pit silos. The making of this class of silage is simple, inexpensive and certain in its results. The system, I think, only requires to be demonstrated to make it universal. It is not practised because its value is unknown and no ordinary cultivator will believe it can be done until it is actually demonstrated to him. If in India we only breed sufficient efficient cattle for our requirements, and if by means of silage we conserved the green fodder which is wasted every year by being allowed to run to woody fibre after the rains there would be no shortage of roughage in this country.

The only way in which landowners can be induced to take a keener practical interest in the cattle-dairy industry is by demonstrating to them that the use of pedigree sires and the adoption of modern methods are financially profitable and this cannot be done as explained in this note, until by State assistance pedigree has been created. In most parts of India the scarcest months of the year for fodder-supply are April, May and June.

The question of the mineral contents of fodder can best be answered by Mr. Warth, but it is certain that in many parts of the country the local fodders are deficient in mineral matter.

I desire to bring to the notice of the Royal Commission a disability under which the Indian cattle trade labours in connection with the transport of milch cattle by passenger train. Indian cows are useless as milkers unless their calves accompany them and the railway companies including State railways charge the same amount for the carriage of a newly born calf by passenger train as they do for a full grown cow or bullock. This is a very great hardship, the cow is no use without the calf and consequently the calf if sold apart from the cow has no value. Besides it does not seem fair that the same rate of freight should be charged for a newly born calf weighing 30 lbs. and of no commercial value as for a cow or bullock weighing say 800 lbs. and worth Rs. 250 to Rs. 500.

APPENDIX I.

Letter No. 2925-A., of 1926, dated Bangalore, the 6th January 1926, from W. Smith, Esq., the Imperial Dairy Expert, Bangalore, to the Honorary Secretary, the All-India Cow Conference Association, Calcutta.

I offer the following remarks on the cattle-breeding scheme sent with your letter:—

To my mind every Province in India *requires* good milch cows and efficient working bullock. My experience goes to show that in Madras of all the Indian Provinces, outside of the immediate vicinity of the larger cities, little or no attention is paid to milk production as a factor in selection for breeding, consequently I cannot agree with you that in this Province "good milkers are keenly appreciated." I do not agree that the advent of British rule either upset the course of Indian social life or ignored the cattle-breeding systems of the country.

I agree with Mr. Blackwood's remarks that the Brahmini system of bull distribution so long as it was the result of strong religious fervour served a useful purpose, but these days I fear religious feeling is not as strong as it was. I have on more than one occasion sold a bull to a Hindu to be dedicated, branded and turned loose and the buyer was by no means anxious to secure the best bull available but he was most anxious to buy the cheapest bull he could get, and in this decline of religious fervour, common to the whole world, these days, lies the reason for the decline in the quality and number of Brahmini bulls. In short the system has outlived its day and is now quite unsuitable.

I think it is rather antiquated to-day to quote, at length from reports prior to 1914. Even the cattle-breeding dairy industry in India has made great strides since that date. I entirely concur that the importation of foreign blood is not a practical proposal for the improvement of the village cattle in India but this and all the remarks made on pages 4, 5 and the first paragraph of page 6 of your note are common knowledge to all who have studied the cattle question in this country. I do not agree that the Brahmini bull is an indispensable factor in improving the breed of Indian cattle. On the contrary the Brahmini system is a broken reed and is to a considerable degree responsible for the present unsatisfactory condition of affairs. The provision, distribution and control of the breeding bulls of the country should be entirely apart from any religious community, sect or organisation whatever and should in no way however remote be dependent on religious or other like sentiment. It is matter of business of serious moment to the whole country. I entirely agree that we need better breeding bulls, better methods of selection, rearing, feeding and management, and no scheme which does not include ways and means of growing and conserving fodder, of controlling the distribution and service of stud bulls, of castrating unsuitable males and of encouraging and developing not only the production of milk but its handling, transport and sale and the manufacture of milk products will really solve this question. Your note gives no details of how all these important matters are to be dealt with and consequently fails to solve this pressing and important economic problem. In short I consider your brief note on the whole states the existing position with care and makes out the need for improvement concerning which we are all agreed, but it is far too vague and incomplete to be classed as a "scheme" for the improvement of cattle-breeding in India.

As all the estimates given in the last page of your note depend upon the use of so called "Brahmini" bulls supplied free I cannot accept your figures.

This is an economic matter, a purely business question and it cannot be solved by an appeal to the religious susceptibilities of any one section of the community.

Mr. W. Smith.

APPENDIX II.

Letter No. 688-R., dated Lahore, the 22nd June 1926, from C. F. Strickland, Esq., I.C.S., Registrar, Co-operative Societies, Punjab, to the Junior Secretary to Financial Commissioners, and Deputy Secretary to Government, Punjab, Development Department.

With reference to correspondence ending with your letter No. 2313-D, dated 1st June 1926, I have the honour to state that the attendance of two gazetted officers and six inspectors at the three months' course in Co-operative Dairying held at Bangalore last cold weather proved to be extremely profitable to the officers concerned, and the students from the Punjab were reported by the Imperial Dairy Expert to be the best who attended the class. Since their return they have been usefully employed in the formation of Milk Recording and Cattle-Breeding Societies in the course of their ordinary duties.

The sanction to sending these officers to the class was granted by your letter No. 656-D., dated the 5th August 1925, and provision has been made in my budget for the current financial year for sending an equal number of officers again to the course in Bangalore. I am now informed by the Imperial Dairy Expert that the Government of India are unable to sanction the admission of Punjab students to the course, but after personal inquiry I understand that this order is due to an apprehension that the Government of India, in undertaking a training class of this nature, may be thought to be trespassing in the sphere of Provincial Governments. The Imperial Dairy Expert is I understand extremely anxious to repeat the course this year, and I feel that it would be of the highest value to my staff. It is not possible to obtain in the Punjab a similar training, either at Lyallpur or elsewhere, and I feel that the anxiety of the Government of India would be removed if the Punjab Government were willing definitely to ask for permission to send Punjab students to Bangalore. The course began last year on September 15th, and there is therefore only a short time remaining within which the arrangement can be made. I beg that, if there be no objection, from the side of the Punjab Government, the Government of India may be moved to sanction the admission of my students.

The financial provision exists in my budget, and no additional expenditure will therefore be involved.

Letter No. 518-D(S)., dated the 13th July 1926, from the Financial Commissioner and Secretary to Government, Punjab, Development Department, to the Secretary to the Government of India, Department of Education, Health and Lands.

I am directed to say that by an arrangement made with the Imperial Dairy Expert, two gazetted officers and six inspectors of the Punjab Co-operative Department were admitted to the three months' course in Co-operative Dairying held at Bangalore last cold weather. The training thus received by these officers, has proved extremely profitable and the students from the Punjab were reported by the Imperial Dairy Expert to be the best who attended the class. Since their return they have been usefully employed in the formation of Milk Recording and Cattle-Breeding Societies in the course of their ordinary duties.

2. The Registrar, Co-operative Societies, Punjab, has now been informed by the Imperial Dairy Expert that the Government of India are unable to sanction the admission of the Punjab students to this course in future. It is not possible to obtain in the Punjab any similar training either at Lyallpur or elsewhere, and the Punjab Government (Ministry of Agriculture) is anxious to secure for its Co-operative Department Officers the very useful technical and specialised instruction imparted at Bangalore. It is understood that the Imperial Dairy Expert wishes to repeat the course this year, and is willing to take Punjab students if he is permitted to do so.

3. The Punjab Government (Ministry of Agriculture) hopes that the Government of India will consent to assist it in obtaining for its officers the advantage offered by the course, and I am accordingly to request that the sanction of the Government of India may be accorded to the admission of the same number of students to the course to be held this year at Bangalore. All travelling and other expenses connected with sending the students to Bangalore will of course be met by this Government.

Letter No. 1458-Agri., dated Simla, the 31st July 1926, from J. W. Bhore, Esq., C.I.E., C.B.E., I.C.S., Secretary to the Government of India, Department of Education, Health and Lands, to the Financial Commissioner and Secretary to the Government of the Punjab, Development Department.

From a perusal of your letter No. 518-D. (S.), dated the 13th July 1926, it would appear that the Government of the Punjab are under the impression that a course in Co-operative Dairying will be held in Bangalore this year, but that students from the Punjab will not be allowed to attend. I am directed to say that this is not the case. The Government of India have decided not to hold such a course this year.

2. They have given their careful consideration to the question whether central institutions, which are intended primarily for research and for instruction of a post-graduate character, should also make provision for elementary short courses such as the one in question and they have come to the tentative conclusion that agricultural or veterinary education not of an advanced character falls more appropriately within the province of Local Governments than of the Government of India. It is possible however that the Royal Commission on Agriculture may make recommendations concerning the division of functions in regard to agricultural and veterinary training between the Central and Provincial Governments which may influence the Government of India to alter this provisional decision. Should this be the case and should the co-operative dairying course or similar classes be instituted by the Government of India, they would welcome the support of these educational activities by the Provincial Governments. For the reason indicated, however, the Government of India do not propose this year to hold the short course in co-operative dairying.

APPENDIX III.

Letter from Mr. W. Smith, Imperial Dairy Expert (on leave), Colinton, Midlothian (Scotland), dated the 16th June 1926, to the Agricultural Adviser to the Government of India, Pusa.

I have been advised by the Assistant Imperial Dairy Expert who is at present acting for me that the Government of India contemplate the closing of the Anand Creamery because they are not satisfied with the trading results of that institution up to date. In the first place, I desire to point out that it is impossible to gauge the commercial success or otherwise of such a factory in the short space of time that Anand has been worked by this department, because owing to delay in the issue of orders as to the taking over of this creamery by the Imperial Agricultural Department it was impossible to commence operations until the cheap milk season, when profits are made in the Gujarat butter trade was past. Secondly, I desire to call the attention of the Government of India to the great national importance of maintaining and extending this, the one creamery or dairy factory, educational and research station, in the whole of the Indian Empire. To take one aspect of the dairy factory problems which to-day deeply affect the economic position in India—the *ghi* problem—the position is serious. The value of the *ghi* produced in India yearly cannot be below Rs. 1,00,00,00,000 per year and it is no exaggeration to say that the existing systems of *ghi* manufacture are crude, wasteful and filthy. These methods are not only wasteful in the outturn of *ghi* which they give from a given quantity of milk containing a certain percentage of butter fat, but they are doubly wasteful in that they make no provision for the proper utilisation of the by-product of *ghi* manufacture, namely separated or butter milk. In many of the districts where *ghi* is made in enormous quantities by jungli tribes who own large herds of buffaloes, the butter milk is simply thrown away in the flush season. This butter milk contains more than half the nutritious constituents of the milk in a highly digestible form, and the present value of dried separated milk in India at the ports is some Rs. 700 per ton. It is certain that under present conditions India deliberately wastes a sum of not less than Rs. 5,00,00,000 per year in failing to make proper use of the by-products in the manufacture of *ghi* and if to this sum there is added another Rs. 3,00,00,000 per annum as representing the actual loss in *ghi* outturn due to crude methods of manufacture, we have the truly colossal loss to the wealth of India of Rs. 8,00,00,000 per annum due wholly to want of technical knowledge and organising ability on the part of those engaged in the *ghi* industry.

It was primarily for the purpose of tackling this pressing problem and of attempting to in some degree prevent this enormous drain on the wealth of India that I pressed Government for so many years to take over the Anand factory and it was mainly with this end in view that I inaugurated classes for the instruction of officers of the co-operative departments of Provincial Governments and Indian States. This *ghi* question and in fact the whole question of manufactured dairy products cannot be investigated or dealt with outside of a properly equipped dairy factory situated in one of the milk-producing areas. No better situation and no more suitable factory site is obtainable than Anand, and to close down this creamery before it has even commenced its work of education and research will be a truly national calamity. The dairy section of the Imperial Agricultural Department cannot do its duty by the country without a thoroughly equipped modern dairy factory and it seems inconceivable that the Government of India will close Anand Creamery and build and equip another creamery at some other place. This question of manufactured dairy products such as *ghi*, condensed milk, evaporated milk and curd products is a truly national one. Every Province, and State, in India manufactures and consumes *ghi* to a greater or lesser extent and *ghi* is manufactured, adulterated, and re-transported from Province to Province all over the country. Not only is this question national from this point of view but it is even more truly national from the public health aspect. It fs saie to say

that there is no food product so universally consumed by all castes and classes as milk, *ghi*, and the milk products; and it is certain that there is no food product eaten in India which is manufactured, handled and adulterated with such filth and utter disregard to cleanliness as *ghi*. *Ghi* is offered for sale in every bazar in India adulterated with every known form of fat from petroleum jelly to the fat obtained by steaming the bones of dead animals. Surely the prevention of this abominable state of affairs is a national question, and this can only be done by the dissemination of knowledge of improved methods, and by the education of the dairy trade. Very little is at present known as to the best methods of manufacture of *ghi* and the milk products from buffaloes milk, research and experiment in this direction is most urgently needed, in fact the whole country is crying aloud for it. This kind of work can only be done at a State dairy factory such as Anand.

The importance of the *ghi* industry alone (only one branch of the dairy factory industry) is certainly of equal magnitude to that of the steel industry in India, and yet the Government of India are paying yearly in bounties to one steel manufacturing company more than the total cost of the Imperial Agricultural Department. I suggest in view of the foregoing that instead of closing down Anand Creamery, the Government of India make provision to extend its activities, and do something for this hitherto neglected but nationally important industry.

Oral Evidence.

A.1. *The Chairman:* Mr. Smith, you are the Imperial Dairy Expert?—Yes.

A.2. You have put in a very interesting note, for which the Commission is indebted to you. Would you like to make any general statement at this stage, or shall I ask you a few questions?—I think you had better ask me a few questions.

A.3. I have your note of evidence before me, and your statement seems to me very clear and complete. But there are one or two details as to which I should like to ask you. On page 6 you say, "I regard the animal nutrition work of the Physiological Chemist as of vital importance to the agriculture of India, and it has been the aim of this office to co-operate with him in every possible direction." I take it that the work of the Physiological Chemist is only at its beginning for the moment?—Yes, it has been going on since 1920, about six years.

A.4. There is a great deal of work still ahead?—Yes.

A.5. And it is your view that the quantity of this work is likely to grow and that a separate herd at a separate farm is really likely to be required in the near future?—I entirely agree.

A.6. On page 7, you make out a case for a dual purpose animal. What indications are there that it is going to be possible to evolve a dual purpose animal, likely to thrive over the greater part of India?—The best breeds we have in the country to-day, such as the Hariana, are dual purpose animals. The Ongole breed in this part of the country and the Scindi in parts of Sind, as well as other less clearly defined breeds, have the dual purpose qualities now. In fact, the best breed of bullocks we have, with perhaps one exception, that of the Amrit Mahal, comes from animals which are largely dual purpose.

A.7. You see no reason why those breeds should not be in a position to provide dual purpose cattle for all the climatic and geographical conditions in India?—Certainly none. The quality of giving milk is the mark of maternity and I know of no reason why a first class mother should not be the dam to a good class of bullock of any type you like.

A.8. I wonder whether you could let the Commission have, at your convenience, a list of the breeds of which you have experience, with any facts about them that you think might be interesting?—I could do that with pleasure. (See Appendix I on page 46).

A.9. On page 8 of your note of evidence, you state the changing conditions which have brought about the contraction of the jungle-feeding grounds available for cattle. In connection with that, have you anything to say, from your experience, about forest management in relation to the fodder problem?—No, I have had very little experience; what experience I have had in dealing with the Forest Department with regard to this problem was in the Military dairy farms, and we found them very ready and willing to co-operate in every possible way.

A.10. Have you anything to say about the preservation of fodder in forests as an insurance against fodder famine?—I think the conservation of fodder or the preservation of fodder is one of the most acute problems in the country to-day, and the storing and conservation of fodder in forest areas would be useful along with that produced from all other types of land in the country.

A.11. On page 9, you point to the castration of unfit males as being an essential step towards the improvement of cattle breeds in India. What degree of prejudice against castration have you met with?—It depends on the locality and the caste of the people. Amongst the Jains in parts of Gujarat, of which I have had a good deal of experience, they simply will not do it at all. I have seen villages in Northern Gujarat, after two or three good years, with as many as 120 buffalo bulls, which were quite useless as breeders, wandering about the outskirts of the village, none of

them castrated. In the Punjab, where you have a large Mahommedan population, and other parts of India, there is very little prejudice. In the stricter Hindu areas there is some prejudice, but I believe it is gradually breaking down. I do not think it is a serious matter to-day, because you can have bloodless castration, which most of the castes will agree to.

A.12. Is it done by crushing?—It is done by the Italian method of simply severing the cords by means of forceps and pressure.

A.13. While on the subject of prejudice, is there any sentimental objection to weaning?—There is a good deal of that in the country. It is entirely prejudice. I do not think it is supported, as far as I can find out, by any real religious teaching on the subject, but there is a prejudice against it. I think it can be overcome. The prejudice exists more among the lower orders who have to deal with cattle, that is, the men who actually attend on them. When I was in the Military dairy farms, we introduced a regulation to that effect and enforced it rigorously, and after the first year or two there was no trouble whatever.

A.14. Does it exist with regard to buffaloes with equal intensity?—No.

A.15. I do not know whether you could enlarge at all on what you have said, on page 9, about the successful experiments in parts of the Punjab in the matter of providing good pedigree bulls?—Probably, detailed information of that sort had better come from the Punjab Government. I have control of a farm in the Punjab, and I am fairly well acquainted with that part of the country. I have spent a good deal of my life there, and certainly the effect of the bulls issued by the Punjab Government is shown in that part of the country where they have been doing it for so many years. It is clearly shown, and to my mind it has effected a distinct improvement. I think the Punjab Government would have done well to have paid more attention to milk in the selection in the earlier stages; but they have taken up that question now, and the breed which they have gone in for primarily for this purpose, the Hariana or the Hissar, as they call it, certainly possesses considerable milking qualities. We are testing some of them now on behalf of the Punjab Government at the farm. We purchased 24 of their cows and we are getting most excellent results. Some of them give quite good yields of milk.

A.16. Is it the case that whereas it is difficult to produce a dual purpose animal designed to produce milk and meat, a dual purpose animal to produce milk and working males is not difficult to come by?—That is my opinion. The best draught bullock in Sweden, for instance, is the Holstein. The whole of South Sweden is cultivated with the Holstein bullock.

A.17. The Commission notes what you say on page 9 with regard to the class for instruction of officers in the Co-operative Departments of all the Provincial Governments and Indian States, and also what you say on page 10 in the matter of the Creamery at Anand in Gujarat. You are very anxious to keep that Creamery in your hands?—I am.

A.18. On page 10, you say "Within the last 20 years India has lost the valuable butter export trade to the Far East because of the inferior quality of her butter, due to lack of technical knowledge of methods of manufacture." Can you give us the facts about that?—I have not got the export figures, but up to practically 1913, there was a large export trade done between this country and Ceylon, Penang, Singapore, right round as far as Hongkong, Saigon, Bangkok, and all those parts. That trade, I am told by the butter merchants interested in it, has been completely lost. I was in Rangoon sometime ago, and when I saw some of the butter merchants there about it they told me that they were so sick of the quality of butter received from India, that they had given it up entirely in favour of Australian butter. In Rangoon they said that although the Indian butter was better for them because of its higher melting point, the quality was so variable and so bad that they could not sell it alongside the Australian tinned butter.

A.19. *Mr. Calvert:* Have you any idea of the volume of that trade?—I have not got the figures as to the volume.

A.20. *The Chairman:* The figures of export for the last 12 years or so do not appear to support the view that there has been a decline?—They would not, because the War came in, and all the butter that could be got from India was sent to the seat of War. The organisation that I was in charge of was sending 11½ tons of butter a day for more than two years. We practically bought the whole of the milk in Gujarat in those days. It was before that that they had this export trade.

A.21. So that the figures between 1918 and 1925 do not show the decline?—No, they would not.

A.22. Before we go on any further with your note of evidence, I should like to ask you whether you support the opinion put forward to the Commission by Mr. Bruen, that the fact that the she-buffalo is the principal milk-producing animal of such a large part of India, is one of the principal obstacles to the improvement of the cow as a milk-producing animal. Perhaps you heard Mr. Bruen's evidence?—I heard his evidence.

A 23. What have you to say about that?—I do not think it is putting it in the proper way to say that the buffalo is a menace to the improvement of the cow. The buffalo is there because of the poor quality of the cow, and I think that the improvement of the cow will gradually eliminate the buffalo. I have been told that that has been the case in Italy, particularly, and in some of the Balkan States. I met the Chief of the Dairy Division of the Italian Government this year, and he told me that because the buffalo was a poorer animal for beef it had been gradually eliminated, as they produced better milkers amongst cows, and I think the same thing will take place here. The cow generally in India gives no milk and therefore the people have to keep the buffalo.

A.24. *Mr. Calvert:* What is the draught animal in those countries, the horse or the ox?—In Italy largely the ox.

A.25. *The Chairman:* The point being, I take it, that you have got to have the bullock to do the work, you have got to have the cow in order to produce the bullock, and if the cow can also produce the milk, then you can do without the buffalo?—Yes. I say the cow can produce milk and ought to; you cannot work the cow.

A.26. So that the order of effort should be to improve the cow first, and you think then she will displace the buffalo?—Yes.

A.27. How about the question of early sexual maturity? Has any work been done on that question?—Early general maturity means early sexual maturity. The age of sexual maturity depends on the degree of development of the animal. If you have better breeding and better feeding, you will get earlier general maturity, and with it sexual maturity.

A.28. Is it the case that cows in India do not, as a general rule, throw their first calf until their sixth year?—It is very difficult to state a figure; it is certainly coming near to that if you take the general average. The cattle on the Government farms throw their first calf nearer the third year, showing that what I say is correct.

A.29. *Sir Henry Lawrence:* You accept it in the villages as nearer six years?—I should say so.

A.30. *The Chairman:* It is a question of nutrition?—It is a question of nutrition and breeding. There is no selection in the villages. The capacity of an animal to make good use of nutrition depends upon the way it is bred.

A.31. One does not usually associate high breeding with fecundity?—Well, we have never come anywhere near to the high breeding in Europe.

A.32. Then I should like at this stage to ask you for your opinion about the Military half-breed dairy farms?—I was employed in the Military dairy farms for 15 years; it was at my suggestion that the Military authorities adopted this system, and naturally I support it.

A.33. The half-breed system?—Yes. I believe myself that the Military dairy farms in introducing foreign blood did exactly the right thing from their point of view. There is no way or method that I know by which

they could have got milk at the price at which they obtain it now from the half-breds. The Military dairy farms organisation was formed and exists for a specific purpose, that is, primarily, to supply the British troops and Indian station hospitals with pure and safe produce, and to get that at the lowest possible figure there is no doubt that they have to employ foreign blood.

A.34. Is it your view that they should continue to employ foreign blood?—It is, as long as their purpose remains as it is now. That is the *raison d'être* of the Military farms.

A.35. It is a question of cost?—It is for entirely economic reasons, as everything connected with cattle-breeding should be.

A.36. Have you measured the advisability of sacrificing economic efficiency in the Military dairy farms and using the agency of the farms for the improvement of indigenous breeds?—I asked at one period of my career in this department that the whole of the Military farms should be handed over to the Civil Department. The then Agricultural Adviser strongly supported the idea, but they were not given to us. At the same time, if we were to use the Military farms for that purpose we should have to alter the system of breeding altogether. I do not believe in the introduction of foreign blood into India for the general improvement of village cattle under existing conditions.

A.37. Second and third crosses are disappointing, are they not?—You will see some of them this afternoon. In a climate like this the second cross, that is, the three-quarters Ayrshire, is fairly good. The seven-eighths are more weedy. The three-quarter is not nearly so good as the half-bred; the seven-eighth is worse. The F. 2 is useless. We bred about 140 of them before the Civil Department took it over, and I think we got about five good cows out of the lot.

A.38. So that although the Military dairy farms are carrying out their primary function very efficiently, they are making no contribution towards the improvement of the indigenous breeds in India?—No; it is not their function.

A.39. Is it your view that these farms should be handed over by the Military to the Civil Department?—I think, if the Government of India could find the extra cost, it would be a good thing for the country.

A.40. How about the milk for the troops?—If they were taken over for that purpose, whatever department took them over would have to guarantee the milk for the troops. It would cost considerably more money in the earlier stages.

A.41. *Sir Henry Lawrence:* Why more money?—Because you would have to revert to a system of using Indian cattle. The present system of the Military dairy farms from a breeding point of view leads nowhere. You would have to build up indigenous herds at each centre. It would cost a great deal of money to do that, but it would be worth it.

A.42. *The Chairman:* You say it would cost a great deal of money; have you any idea how much?—Without going into the details I cannot answer. There are 34 of these farms, and they differ in every possible way.

A.43. I observe on page 11 you think that there is ample scope for the Veterinary Services in the prevention and cure of animal diseases?—Yes, the prevention and cure of animal diseases I consider to be their function.

A.44. Do you attach importance to breeding and heredity in relation to resistance to disease?—Yes, it is a factor undoubtedly.

A.45. Have you anything other than that which you have set down in your note that you wish to say about the Veterinary Services or about Muktesar?—No; generally speaking I have found the Veterinary Services very ready to co-operate so far as they possibly can. My experience, of course, has been more with the Army Veterinary Department, as I was much longer in the Military Department than I have been in this department, and we found them exceedingly useful in their own sphere.

A.46. What about Muktesar?—Muktesar has given me a great deal of assistance here. They also carried out the simultaneous inoculation for eight years of my service in the Military dairy farms with extraordinary success. We simultaneously inoculated between 1912 and 1916 practically the whole of the animals under my charge in the Southern District of the Military dairy farms. This was done by Muktesar, with practically no loss. Since then there has been practically no rinderpest and no losses from rinderpest in that area.

A.47. *Mr. Calvert:* What is wrong with Hissar?—I do not think there is anything wrong with it.

A.48. Why do you say you would rather take it away from the Veterinary Department? It has been under veterinary control for many years?—I consider the officer in charge of Hissar is probably one of the best farmers and one of the best stock breeders we have in this country. Apart from being a veterinary officer he is a trained and experienced farmer, and a skilled breeder. His work at Hissar is beyond praise; there is nothing wrong with it.

A.49. Do you think it is impossible to have other veterinary officers of the same type?—I think it would be a great pity, in view of the extraordinary need for skilled veterinary men, to turn these men away from the prevention and cure of animal disease. The country cannot afford it.

A.50. *The Chairman:* Do you think yourself that the time has come for an All-India Act dealing with epidemic animal diseases?—Do you mean the restricting of the movement of animals?

A.51. I do?—No.

A.52. Why?—I do not think it could be given effect to. You would have to increase the Veterinary Service to a much greater extent, and that would take time. It would have to be extended and very much more spread over the country, to do anything like that with efficiency. I speak as a layman in regard to that.

A.53. Do you wish to add anything to what you say on page 11 as to the advisability of the formation of a Central Cattle Bureau according to the recommendation of the Board of Agriculture?—Yes, I believe that that Central Bureau would do very good work; but I do not think that such a bureau can take the place of a general central organisation for the guidance and co-ordination of agricultural effort in the country. The Cattle Bureau will perform a specific work if it gets the necessary staff; it has not been provided with it yet.

A.54. I grasp your plan for the organisation of research work and subsequent breeding experiments. Have you worked out in detail how you propose to get down to the cultivator?—Do you refer to dairying research or cattle-breeding?

A.55. In regard to dairying first?—We have first of all to discover how and under what conditions we have to carry out these various operations. As soon as we are able to say definitely how that is to be done and we get the results of our research work, I should be greatly in favour of getting to the cultivator through the agency of the Co-operative Department. I believe that this particular industry, the manufacture of milk products, is specially suited for being carried out on co-operative principles. That was the very reason why I started this class for co-operative officers to get into touch with these men to find out what their ideas were and how much we could assist them. In my opinion in this country if industries of this sort are started by private enterprise the real producer of the milk will not get a proper share of the profit. In practically every country in the world where they have made a success of dairying they have taken up co-operation for the factory part of the work. It has been particularly suitable.

A.56. Have you personal experience of producers' co-operative organisations in this country?—No, I have very little experience in this country. I have experience of it in some other countries.

A.57. But not in this country?—No.

A.58. Have you formed any view as to the soundness of the co-operative societies in this country?—I have come into touch with very few of them. The only ones I know intimately are the Calcutta Co-operative Societies Milk Union; I regard it as a sound and very well-managed concern. They are doing wonderful work in Bengal at the present time. I have advised them ever since I came into this position.

A.59. Where you can establish co-operative dairying, of course you would at the same time establish your machinery for the improvement of breeds?—I should hope so.

A.60. Now think for a moment of villages where dairying would not be taken up. How do you propose in areas of that nature to get down to the villagers and to show them how to improve their working cattle?—The first thing is to supply them with a bull or bulls, and to see that the other males in the village are castrated. That is the first thing that has got to be done, but before we can do that we have got to build up a pedigree. If you will pardon my saying so, I do not think we can worry about crossing the bridge before we reach the stream. The first thing we have got to do in this country is to get pedigree. I have got animals for Government which were supposed to be pure; we sent them long distances at great cost; they were beautiful animals to look at. We made every enquiry we could about their ancestry, but when they started work they produced a collection of weeds. That is happening all over the country. It is no use distributing bulls until they have some power of handing on the qualities they are supposed to possess.

A.61. I quite agree if I were in your shoes I should not worry about crossing the bridge yet; but from our point of view this question of getting down to the cultivator is of such interest and general application that we like to ask witnesses if they have thought the matter out?—There are two or three agencies which you could employ. Co-operative societies would be a very good thing. The bulls distributed in the Punjab are looked after as far as their maintenance and health are concerned, by the Veterinary Department who have a staff large enough to deal with it; that is necessary too.

A.62. You think that is a good scheme?—In the Punjab it works very well. Any agency that will look after the bull, see that the use of other bulls is prohibited, and more or less keep a record of the servings accurately, is good enough. You may use the panchayat or the co-operative society, or you may use the Government of India Department.

A.63. You do not think that by employing the Veterinary Service in that direction you would distract their attention from disease problems?—I think the Veterinary Department could do it quite well, but at the same time it must be borne in mind that if you give them a great deal of that to do, they cannot do the other. The efficiency in that case would depend upon the quality and quantity of the staff they have. I do not think it is of any importance what agency does it; the point is that it has got to be done.

A.64. I think the difficulty is the vast area and the enormous number of villages?—That, of course, is a question of ways and means. I do not think there is any difficulty underlying the principles applicable. The greatest difficulty now is to get the cattle.

A.65. Have you formed any idea as to how long it would take you, given the means that you require, to evolve on pedigree lines?—I should think you would effect a distinct improvement on the third generation and even the second would be better than what we have now. The first is selection, the second is breeding by selection, and the third goes on accumulating the benefit. The effect of all this is cumulative from every point of view.

A.66. Are you satisfied with the facilities for teaching dairying at the Institute?—No, I am not satisfied.

A.67. Do you wish to add anything to your note in that respect?—I think it should be considerably extended, the staff should be increased and the

students' hostel accommodation especially should be increased. We had a great many more applicants for this Diploma class that we teach than we were able to take in both cases. I think from the dairying point of view, unless we can turn out men of the practical type that we are attempting here to turn out, there is a very little hope for the dairying industry. The people who now run it have very little knowledge of the technique of the subject.

A.68. Do you keep in touch with your Degree and Diploma men?—I have only passed out one class of Diploma men; I am in touch with all of them It is not a difficult matter at present.

A.69. Do they come from a wide area of the country?—They come from all over India. The present class is the same. We made our selections purposely in that way. The first time we took one-fourth of the number of applicants, and this year we took about a third. We took them from all over India, not only from a geographical point of view, but from different castes as well.

A.70. Accurate records of their careers will be very interesting in a few years' time, will they not?—Yes. We are not keeping official records, but we could easily do so.

A.71. Following the order of your note, I gather that you have little hope of making scientific modern dairying an economic proposition until reasonable standards of purity and hygiene are insisted upon in the large consuming centres?—That is so.

A.72. Are you thinking of local Acts to enforce standards of that nature, or have you in mind an All-India Public Health Act?—I do not think it matters whether it is All-India or Provincial. As a matter of fact in the larger centres to-day they have got statutes having the force of law which would adequately protect the dairy industry if they were enforced. In Bombay, Calcutta and Patna, I myself was called upon to advise with regard to the drawing up of these Acts, and the standard there adopted, which has now the force of law, would be all right if it were enforced; but I venture to say that in these three towns the milk sold is so bad that it can hardly be described. Mr. Bruen told you, I think, that you can go to a milk vendor in Bombay and he will say, "you can have pure milk or any grade you like below that", and he adds the water. I quite agree with Mr. Bruen. It is contrary to law in Bombay to adulterate milk, but public opinion has not got to the point at which this law is enforced. It is I believe improving.

A.73. I gather from your note that you find provincial officers very ready as a rule to co-operate with you?—Yes, we keep in touch with all the provincial cattle-breeding officers, and where there is no specialist cattle-breeding officer we have been in touch with the Director of Agriculture.

A.74. Do you think provincial cattle-breeding officers are in touch with the work of cattle-breeding officers in other Provinces as well as with your work?—I am afraid they are not. There is no means. That is one reason why the Board of Agriculture pressed the establishment of the Central Cattle Bureau so that there would be a central way of their coming together and each finding out what the other was doing. Most of the cattle-breeding officers and directors of farms write to this office and keep in touch with this office for technical information regarding dairying matters more than cattle-breeding.

A.75. It is no part of your function to correlate the work as between Province and Province?—No, not to my knowledge. It will be part of the function of the Central Cattle Bureau when it is organised.

A.76. What dairying and cattle improvement journals have you in India?—None.

A.77. Is there room for a journal of that sort?—I think there is. I believe Dr. Clouston has proposed the establishment of such a journal.

A.78. In the meantime you have occasional articles in other journals?—We have occasional articles in the *Indian Agricultural Journal*, when we have time to write them.

A.79. *Sir James MacKenna:* I see that in your memorandum you lay great emphasis on the retention of the Anand Creamery?—Yes.

A.80. Do you not think it would be better to take the opportunity of starting a new model factory instead of retaining Anand?—No. The Military dairies took two years to get a suitable site in days when the Government of India had control of the land there. Now the land and all that sort of thing is controlled by the Provincial Government. I think it would be impossible for us to get any site anything like as suitable as Anand for the establishment of an experimental and educational dairy factory. Anand is situated at the junction of four railway lines, right against the station; it has got a first class water-supply, and that is very valuable. It is very difficult to get a good water-supply for a creamery; a creamery requires a great deal of water.

A.81. The future of this creamery is somewhat in the balance?—Yes.

A.82. Do you think that the maintenance of this creamery is a matter of such importance that the Royal Commission should make an *interim* recommendation apart from their final recommendations?—I would greatly appreciate it. I have suggested that the Commission should send some one to see the district and see its extraordinary possibilities from a dairying point of view. It is the one real dairying district in India.

A.83. I see from page 10 its position is precarious?—I have been told so.

A.84. You recommend that the Royal Commission should, if possible, depute a section if not the whole Commission to visit it?—It would be a very good thing. I think they would agree with me when they see the place and conditions.

A.85. What special lines of research and experiment have you been able to take up since you received this appointment, on the various farms you have?—We have taken up very little of experimental work. All that we have taken up with regard to cattle-breeding is the demonstration of dual purpose animals, like the Hariana. We have also carried on cross-breeding work here with a view to demonstrating milk production. In regard to investigation into dairying problems, we have done some original work here in connection with the neutralisation of sour cream by lime, and the sterilisation of milk, one or two minor points of that type; things that could be taken up here were done by the dairy staff with the assistance of Mr. Warth. Mr. Warth, who happens to have his laboratory there, has co-operated loyally with us. We have been able to do one or two little things like that, but generally speaking we have not yet tackled any of the major problems.

A.86. What happened during the gap of three years between your appointment as Imperial Dairy Expert and the taking over of your farms?—Nothing happened. We had no funds and no facilities to do anything. I used to write to Mr. Milligan almost every day for three years and then we got these three Military dairy farms.

A.87. How did you keep yourself employed?—By giving advice and drawing up plans for people, things like that; we did what we could; I think the time was wasted.

A.88. So that you really lost three years?—Yes.

A.89. What do you think is the main cause of the inferiority of cattle in this country? Is it due to lack of means, or lack of care, on the part of owners?—I think it is lack of knowledge. The breeding classes are probably the most ignorant and prejudiced people in the whole country. They had vast areas to roam over in the old days, and they are now restricted, with the result that they have turned into professional fodder thieves. I think you will agree with me that in Northern Gujarat they certainly are professional fodder thieves. We want to get cattle-breeding into the hands

of a better class of people. That is why I stress the point that the cultivator must be the breeder.

A.90. *Dr. Hyder:* Where were these vast areas of which you are speaking?—There were vast areas in the Punjab; there are now vast areas in Bihar and Orissa, and North Arcot (Madras).

A.91. Where are these areas in the Punjab?—The present canal areas were all given over to cattle-breeding. The Sutlej Canal has been brought into a district which was occupied by cattle-breeders. In Montgomery there was nothing but cattle-breeding; Lyallpur district was the same.

A.92. My point is that at present these areas do not exist in the Punjab; the land is under the plough?—Certainly it is, but they were grazing areas before the canals were excavated. The canals have converted these areas into agricultural lands now. It is the canal which has driven the cattle-breeder into the corner.

A.93. But these jungle cattle-breeders have taken to cultivation?—They are gradually. Attempts are being made to get them to take up land and in some instances they have done so. Generally speaking, I believe the men who were brought in as cultivators were not the jungly cattle-breeders.

A.94. In Bihar you say there are vast areas?—There are vast areas in the hill tracts of Bihar now that are given over to cattle-breeding. Then in North Arcot there are thousands of acres of it, covered with cattle, the worst weeds you have ever seen. There is no system whatever in the breeding.

A.95. *Sir James MacKenna.* With reference to your answer to the Chairman as to All-India legislation on cattle diseases, apart from the necessity for increasing the veterinary staff to enforce such legislation, do you consider a considerable strengthening of the Veterinary Department is desirable in the interests of agriculture?—It is certainly.

A.96. Do you think that if by the strengthening of your Veterinary Departments you can save the lives of 4,000 animals, that would be equivalent to an enormous increase?—Yes, that is so; I believe it would be entirely economic to increase the veterinary staff enormously.

A.97. Are there any points on which you consider an early expression of opinion of the Commission, in connection with this new branch of agricultural research is necessary in order to prevent the stopping of important work?—I think it is of vital importance to the Central Department of Agriculture that something should be done to modify the existing Devolution Rules. I believe that the lack of funds from which we are suffering and the restriction of our work is largely due to the fact that under the Devolution Rules there is no real place for a Central Department of Agriculture. It is distinctly stated in those rules that Agriculture, including research, is a Transferred subject, and consequently the Government of India rightly feel that they cannot co-operate with the Provinces if it costs any money.

A.98. Such co-operation is of course absolutely essential for the development of your work?—Yes, undoubtedly. This co-operative class of mine that I was so keen on has been stopped solely on account of that. They say, "Really it is exceeding our powers under the Devolution Rules."

A.99. In these one or two matters, would an *interim* report or expression of opinion of this Commission be of the very greatest help?—It would.

A.100. Both to you and probably to the Government of India?—I think it would.

A.101. And to Local Governments too, probably?—Yes.

A.102. There is no lack of will on the part of Local Governments. In point of fact the correspondence shows there is a desire on the part of Local Governments to have the advantage of this centralised instruction or assistance and the letter attached to your memorandum has probably been written with the authority of the responsible Minister?—I think so.

A.103. So that is looks as if it were a point on which, if this Commission could give an expression of opinion, there would be unanimity of acceptance?—Yes.

A.104. *Professor Gangulee:* In reply to Sir James MacKenna you stated that you were appointed in 1920 and that for three years you had practically nothing to do?—I did not say that. I said that I did not have the legitimate work that I should have had to do. I occupied my time as well as I could.

A.105. And during that period your expenditure was something like Rs. 98,000?—It was Rs. 26,000 in 1921; Rs. 33,000 in 1922; and Rs. 39,000 in 1923. That is, about Rs. 98,000.

A.106. Now with regard to your educational system, I see that you have got something like a graduated system of dairy education. In the first place, you have got the post-graduate arrangement; then the Diploma arrangement and the short course arrangement. The Diploma course is for two years?—Yes.

A.107. Could you kindly give us an idea of the syllabus?—I have given every member a copy of the syllabus.

A.108. In the short course you have 74 students?—We had, during the last two years.

A.109. How are the students utilising their knowledge?—Nearly all of these men were officers in the various departments of agriculture, with the exception of a few students engaged in the dairy business. They were nearly all men sent to us by the various agricultural departments throughout India, and they returned to their posts after they had finished.

A.110. So that there is that degree of co-operation between yourselves and the Provinces?—Yes.

A.111. On page 6 you have answered the point about research work. You state here that little or nothing has been done to solve the many pressing problems affecting the dairying and cattle-breeding industry. Are you referring to any fundamental research?—I have specified some of the lines of research that, I think, are most generally needed. I would class these as fundamental.

A.112. And you have not been able to undertake any of these researches?—No.

A.113. You lay a great deal of emphasis on the dairy industry. Are you of opinion that the dairy industry in India has a great future before it?—I am.

A.114. You say, in reply to a letter from the Honorary Secretary of the All-India Cow Conference, that even the cattle-breeding and dairy industry in India have made great strides since 1914. Can you tell us in what particular direction these great strides have been made?—Principally in the establishment of this place here and in the appointment of Cattle-Breeding Experts by almost all the Governments in India. There was nothing done before that. These two things I consider were the first real movement, and they are of great importance.

A.115. Do you agree with me that the dairy industry depends to a great extent on the climate, the soil, the water and fodder-supply of certain regions?—All these are factors.

A.116. Have you undertaken a survey showing what may be called the potential dairy areas in India?—No.

A.117. Do you not think it would be useful?—It would be, but it is not nearly so important as the improvement of the cattle and the investigation of the dairy problems. It is of no use my being able to say that this particular place is fitted for the dairy industry until I can tell the people how to conduct it.

A.118. Would it not be useful if you could define a dairy belt in India?—There is no dairy belt.

A.119. The dairy areas?—I do not think you can classify it. The whole country must be dairying because the whole country must be cattle-breeding. You cannot work India without cattle; you cannot get a bullock without a cow and therefore the cattle problem arises all the time.

A.120. Do you not think that geographical limitations are a great handicap?—They are a factor, but they are not the primary factor.

A.121. With regard to the dairy industry, you recognise that a scheme for milk-recording is fundamentally necessary?—Yes, it is.

A.122. Have you adopted any such scheme?—Yes, we have. Records on these farms have been kept carefully of every drop of milk produced since they were started. On this farm, and in fact all the Government farms, there is a record kept of every drop of milk since it was started. That applies to Pusa.

A.123. Is there any recording of milk among the cultivators?—Generally speaking, none.

A.124. *Dr. Hyder:* Have you got any figures of the average cost of such a scheme of milk recording and testing?—No, I could not give you the cost of anything like that; our figures are too much intertwined. There is one man who does this work, and of course he does a great many other things as well.

A.125. Are you aware of the cost of such schemes in other parts of the world?—Well, generally speaking.

A.126. Is the cost high or low?—Low. A great part of the work is done by the staff that would in any case be there. The authenticating of the records is the thing that costs money. That is generally done by central bodies with Government assistance; in fact, it is done all over the world in this way. That, I think, should be one of the primary functions of this Cattle Bureau.

A.127. *Professor Gangulee:* On page 8, you refer to these dairy products as being a village industry. You do not conceive of a time when the dairy industry could be run on a factory scale?—I do.

A.128. Do you think it could be a village industry run on factory lines?—Well, we could have a factory where we have collected milk. You can make cheese in Scotland, where you have got large enough holdings to provide a sufficient supply, but you cannot make cheese in Ireland on the farm; you have to have the factory system, and the same applies to Holland and Denmark which have a village factory industry. In fact, I go further and say that it cannot be economically worked upon any other basis. All that would be necessary would be your plant and buildings.

A.129. On page 8 you say, "The building up of pedigree herds in India must be a losing business for many years to come and therefore it can only be done by the State." What breeds in your opinion should form the foundations upon which dairy herds could be built?—The Scindi, the Thar Parkar, the Hariana, the Ongole of Southern India, the Amrit Mahal (I should get milk into the Amrit Mahal), the Dangi as it is called. These are probably the most pure and the breeds from which we are most likely to get good results at an early date.

A.130. Have you got any definite data to show that these breeds that you have just mentioned should be the foundations upon which dairy herds could be built?—I have definite data of them all except the Amrit Mahal.

A.131. What was the basis of your selection of stock?—The basis of selection was the milking test *plus* form. Every animal I bought I milked for two days; in fact I have never bought a cow in this country without having her milked in my presence, and I weighed the milk myself.

A.132. *Mr. Calvert:* Do you omit the Sahiwal breed?—Yes, I omitted it advisedly. It is not a dual purpose animal; it is not good for draught in my opinion.

A.133. Would you include the Dhunni?—It will make a very good foundation. It has no milk, but in that respect it is like the Amrit Mahal. It is a very distinct breed, and it is a very good one.

A.134. *Professor Gangulee:* So milking quality is the basis of your selection?—No, milking quality *plus* draught quality, or one can put it the other way round. I say they have got to go hand in hand.

A.135. There are two qualities certainly, milking and draught?—Yes.

A.136. In milking quality, do you go by the percentage of butter fat?—Yes.

A.137. With regard to the distribution and control of pedigree bulls, do you think the registration and inspection of breeding stock would be required for the improvement of the livestock of the country?—Registration and inspection of pedigree herds will certainly be required.

A.138. The Government of North Ireland have introduced a system of compulsory registration?—They have.

A.139. Do you think the time has come for this country to adopt that measure?—No, not nearly come.

A.140. With regard to castration of unfit males on an organised scale, would you make it compulsory?—That again is a veterinary question. It would be a very good thing if you could do it, but it is no use making anything like that compulsory until you have a fair chance of enforcing it. I do not think with the present staff and arrangements it could be enforced.

A.141. If you had the staff and the machinery, you would be in favour of it?—Yes.

A.142. You think it is fundamentally necessary?—I think it would be a very good thing.

A.143. With regard to the service bull, have you any scheme by which this service could be made popular?—Give it for nothing, and have no other bulls.

A.144. You would not utilise the Local Boards and District Boards for the purpose, to give it free?—Yes, that is what I mean; give it free, charge nothing, and have no other bulls. There is no doubt as to the popularity of that.

A.145. You will make it popular if you give it free?—Yes.

A.146. *Dr. Hyder:* They are unpopular if you give them free, are they not?—No; where they get them for nothing the bulls which have been distributed by most Governments are very popular. In fact, the tendency in most cases is to give them far too much work.

A.147. *Professor Gangulee:* From your experience of the co-operative organisations in Europe, do you think co-operative organisations could be utilised as a suitable agency for the improvement of livestock in the country?—I do.

A.148. The conditions affecting the dairy and cattle-breeding industry in this country are widely different from those of Europe, are they not?—They are.

A.149. Do you think we could possibly utilise the co-operative organisations in the same way in this country?—I should certainly think so. I see no reason why we should not; human nature is the same throughout; that is the basis of it all.

A.150. *Mr. Calvert:* I am not yet clear in my own mind on this question of the deterioration of cattle. You say that the quality of the cattle of India gets worse from year to year? Do you put that forward as a scientific statement or just a popular opinion?—It must be a matter of opinion.

A.151. I was thinking of the Sind Sagar Doab, where conditions are exactly the same as they were hundreds of years ago, and where the people still live by grazing?—Yes.

A.152. The class of cattle there is very poor?—Yes. There may be areas where the cattle have not deteriorated, but taking the country generally, they have. I have been travelling in this country for 21 years, and I travel about 15,000 miles a year. Since I came to this country, I certainly think, the quality of the cattle has deteriorated. Except in parts of the Punjab, where

you have really made an impression with your Hissar bull, you can see in all the villages they are getting worse. I have bought cattle in the Punjab since 1906 up to a year or two ago, and every year, believe me, the cattle at the Amritsar fair are getting worse and worse. Mr. Keventer told me in Poona last week that he does not go near the Punjab now. His buyer used to visit the Amritsar fair regularly in October for many years, and every year he now goes to another part. Mr. Keventer says exactly the same thing, that the quality of the animal he can get to-day is nothing like so good as the quality of those he got 25 years ago. I have spoken to Forest Officers and people in various parts of the country, and particularly the Forest Officer in Dharwar who has been there many years. The zamindar of Kangundi, who is one of the largest cattle-breeders in North Arcot, is also of the same opinion. All of them support my statement.

A.153. May not that deterioration of the cattle at the Amritsar fair be due to the fact that the people are now so prosperous that they can afford to keep their best cattle?—That may be a factor. The fair that is held 14 miles south of Rohtak I have attended twice with an interval of 16 years, and I am satisfied that there also there was a great deterioration. I bought a number of cattle on both occasions.

A.154. Is that Jahazgarh?—Yes, it is one of the biggest cattle fairs in India.

A.155. You say the people of India will not put the female of the ox to the plough?—Yes.

A.156. Is that general throughout India?—Absolutely.

A.157. It is not universal but it is general?—It is nearly universal.

A.158. Plough cattle are exempt from attachment for debt. Have you heard of cows being utilised for the plough to secure that exemption?—No.

A.159. I gather you think that at present there is no hope that private enterprise will build up pedigree herds?—No.

A.160. Are you in a position to amplify your explanation of the objections raised to the continuation of your courses here at Bangalore for co-operative students?—No, I have never been told the reasons. All that I know is the letter which you have.

A.161. When you speak of dairying, are you thinking of the keeping of cattle in order to sell their products, or for home consumption?—For both.

A.162. But they are two very different problems, are they not?—There are many variations of the dairying industry. The production and handling of milk is dairying. What you do with it afterwards is of course only one of the many details of the business.

A.163. I am thinking of the difficulty in the way of bringing into being anything approaching efficient dairying in India. You mentioned in your note the religious objections to getting rid of inferior cattle. Does not that objection also make it difficult to put into the herds better and better cows as they reach maturity?—No.

A.164. If you put a better cow in, it must displace the inferior animal?—Yes.

A. 165. But if you cannot get rid of the inferior cow, you are in a difficulty?—You can in course of time. The inferior cow has got to die. What you have to do is to look to the future and see that everything that is coming on is better. There is no other way. There is no objection to doing it in that manner; it has got to be gradual.

A.166. That difficulty of the elimination of the poorer animal is a very big obstacle in the way of introducing better blood, is it not?—It is, if you want immediate results, but it is not in the long run. We are not in a position to give immediate results anyhow, generally speaking.

A.167. Have you any experience at all of milk recording by private bodies in India?—Very little. Mr. Keventer does a little of it, and also one or two private owners. One or two people do it, but it is very little.

A.168. Do you think it is within the capacity of the ordinary cultivating class?—With a little organisation, it is.

A.169. You have not seen the milk-recording societies started by your students in the Punjab?—I went round with Mr. Strickland for two or three days. He talked with the people, and he seemed to think that it was quite a practicable proposal.

A.170. It is promising?—Yes.

A.171. *Dr. Hyder:* Does Mr. Keventer keep buffaloes or cows?—He keeps both. He keeps cows entirely at Simla, and he has a number of buffaloes at Aligarh. He buys all the milk for butter-making. He produces butter, but he buys the milk for that.

A.172. *Mr. Calvert:* With regard to this question of the drain of good milking cows to cities, do you think that is a considerable drain?—It is; it is a considerable drain, because of the fact that the number of real good milking cows in the country is so small. They only buy the best in the cities.

A.173. Do they take the best?—They do, undoubtedly.

A.174. Then they are lost for breeding purposes?—They do not breed any more.

A.175. I gather that by dual purposes you mean a fair milker and a fair draught animal?—That is so.

A.176. Of what standard as a milker are you thinking?—I should aim at a standard to commence with of 3,000 lbs. per year for a milker.

A.177. What about the draught animal?—It must be a suitable plough bullock for the district. I cannot define it more clearly than that.

A.178. In your note you say there is a great deal of inefficiency of cultivation owing to the inefficiency of the bullock?—Yes.

A. 179. Does that apply to places like the Punjab?—To parts of the Punjab it does, and to parts it does not. Round our place at Karnal the people tell me that the bullocks cannot pull the improved plough which we want them to use. Our bullocks can pull the improved plough without the slightest trouble. It applies equally to the Punjab.

A.180. Then you think you can get the milk into the Hariana, but cannot get the draught into the Sahiwal?—It is not necessary, because in the Hariana breed you have probably got a more suitable and more likely animal to work with. The Hariana, which we have, are milking wonderfully. Cows that have never been recorded before are now giving up to 3,000 or 4,000 lbs. The Hariana is a really good dual purpose animal.

A.181. The Hariana was going too much for draught?—Up to a year or two ago they paid no attention to milk.

A.182. They were breeding for the Artillery?—They were breeding for the urgent demand and they had not the staff. I believe they are getting the staff now.

A.183. They had to breed for the bullock batteries?—They did. They bred for the Army many years.

A.184. Do you think that there is much advantage to be gained from selecting suitable young stock from villages and sending them to a Government farm to be looked after in the early years?—No, I do not think it is of much use. I think it would be far better to confine one's efforts to selecting and then breeding carefully to produce pedigree.

A.185. You have got a farm at Hissar which is the biggest in India, but the number of bulls which it can turn out every year is strictly limited?—Yes, but it is to be very rapidly increased.

A.186. Have you tried selecting young animals from the villages and taking them to the farm to be well looked after?—It is not nearly so good as what they are doing at Hissar with their own cattle. They have generations of pedigree and the animals produced will be sure to be what is wanted. I have done a great deal of it myself.

A.187. *Sir Henry Lawrence:* What are the figures of bulls turned out at Hissar?—I do not know.

Mr. Calvert: They have been turning out 300 a year, but now they are increasing that. They hope to double it shortly.

A.188. *Sir Henry Lawrence:* For your ultimate ideal of cattle in India, you would have only pedigree bulls from Government farms or from known stock?—Yes.

A.189. Gradually eliminating the whole of the scrub bulls we have got?—There is no other way to get the result.

A.190. *Mr. Kamat:* You have told the Commission that in Great Britain private enterprise was able to raise pedigree herds, and yet you say that in India it is an impossibility?—Yes.

A.191. You have also stated on page 8 of your memorandum that cattle-breeding farms in India cannot be expected to pay their way for many years to come?—Yes.

A.192. You stand by that?—I do.

A.193. I want to know how you reconcile that with your statement on page 9 with reference to the cultivator that " if he uses the right breeds and practises the correct methods, cattle-rearing and the growing and conserving of fodder crops for this purpose as a regular part of his agricultural operations will be profitable." Apparently it is not profitable for Government with all their resources and it is not profitable for the big landholder. How can it be made profitable to the small cultivator?—If you read on to the next paragraph you will see that I distinctly say that this cannot be done by the cultivator until we give him pedigree bulls. It is the evolution of the pedigree that is going to cost the money. That is what is not profitable.

A.194. The bigger landowner can get the predigree bull?—No, I have said he cannot; it must be done by the State.

A.195. The State can get the pedigree bulls?—Yes, if it pays the money, but it must be unprofitable commercially.

A.196. And yet you say that Government cattle farms cannot pay their way?—Certainly not, as long as they are making the pedigree.

A.197. So that that is not the chief factor?—Yes, it is the one and only factor.

A.198. But I understand you to say it is not profitable for the State or for the big landowner, and yet it is likely to be profitable for the cultivator?—It will be profitable for the cultivator when we give him the pedigree. It is the manufacture of the pedigree that will be unprofitable.

A.199. Can you give me a rough idea how long it takes for the cultivator to sell his young stock, and what would be the cost of maintenance of his animal, even if you gave him the pedigree bull. Will it take three years or four years?—It all depends. In some parts of the country they sell their young stock when they are weaned. In others they rear them. In some parts they break them in as bullocks and sell them.

A.200. Till then he has to maintain his cow?—Yes, and its calf.

A.201. It is not an economic proposition; he loses every month?—Not necessarily. If he has the proper class of animal bred from a pedigree bull he will not lose; it will be a profitable business.

A.202. From the commencement?—From the commencement of the time that he gets a proper type of pedigree bull.

A.203. From the very commencement you say it will be profitable for him; that is to say, the milk yield has a value which covers his expenses?—That, of course, depends on the class of cow he is using.

A.204. Given a pedigree and the class of cow, the yield of milk covers his daily or monthly expenses. Is that so?—Well, that ought to be our aim. At the present time it does not.

A.205. I am asking you, ' could you make that so ' ?—I can.

A.206. If it can be made a self-supporting business given these two things, I wonder why Government cattle farms could not also be made self-supporting?—They would, when they have got a pedigree. It is the elimination of the unfit, in order to establish a pedigree, that is going to cost the money. What are you going to do with the rejected? You start with animals that are selected. You know nothing about them from the breeding point of view. You will probably get five out of seven that are worth keeping. What is to be done with the other two? Who is to bear the loss of those that are of no use? It is the building up of the pedigree that is going to be the expensive thing, and the aim is to produce a pedigree which will make it more profitable for the cultivator.

A.207. *Mr. Calvert:* Have you seen the progress of the cow-breeding colonisation scheme in Montgomery?—I have been there.

A.208. Is it hopeful?—It is hopeful.

A.209. That is where a grant of land is given to the cultivator on condition that he maintains an approved type of cow?—I saw all the cows in the colony with Mr. Strickland, and I think it is a very good thing.

A.210. *Mr. Kamat:* You told us that in this competition of the buffalo against the cow, it is possible that the cow will eventually eliminate the buffalo. Is that right?—Yes.

A.211. How long will it take to evolve a type of cow which will give such milk as will enable her to displace the buffalo?—That depends entirely on the amount of funds and the staff which are allotted for the purpose.

A.212. Given the funds and the staff, how long will it take you to evolve a pedigree breed? Will it take three generations or four generations?—I should think there would be a very marked improvement in 25 years.

A.213. Till then the cow cannot hold her position?—She will gradually make her way. She is here now, and she should be getting better every year.

A.214. You think that the cow can eliminate the buffalo?—I believe it can, and I believe it must.

A.215. Do you think it will take 25 years?—I say it will take longer than 25 years; but there will be a marked improvement in 25 years, provided the staff and the funds allotted are adequate.

A.216. You say that the policy of the Military dairy farms was detrimental to the general interest of cattle-breeding, as it was based purely on the economic principle of getting the highest yield of milk. If this cross-breeding system is inevitable in the case of the Military dairy farms, purely from an economic point of view, will it not also be inevitable for the private cultivator who wants to go in for the dairying business?—I did not say that the policy of the Military dairy farms was detrimental to the general cattle-breeding of the country. In my opinion it has had no effect whatever on it and it has nothing to do with it. It has not affected it, nor is it likely to affect it in any way.

A.217. You do not agree with Mr. Bruen on that point?—I disagree with him most emphatically.

A.218. The prejudice against castration exists only in certain parts of the country. In other parts castration in an approved form is carried on?—Yes, by the Italian method.

A.219. You say the dairying business has a future in India. May I know then why the fate of the Anand Creamery is hanging in the balance? Is it not the fact that Government are trying to close it down because it is not a commercial proposition?—That is so.

A.220. Why is it not a commercial proposition for the Government?—Because it has been established in order to carry on investigation and to teach students. We have the full complement of students just now. There

are no dairying educational institutions in the world that I know of that pay their way commercially.

A.221. You say in your memorandum that something could be done with butter-milk as a bye-product of milk?—A bye-product of *ghi*.

A.222. Have you published any bulletin as to what could be done with it?—I have not.

A.223. Government have not yet taken any steps to publish the results of your research?—I cannot tell you what can be done because I have not made any experiments.

A.224. You feel something could be done, but you are not in a position at the present moment to say what could be done?—I am certain it can be done.

A.225. It is a matter of research?—It is a matter of investigation. Conditions with regard to buffalo milk are so different from the conditions with cows' milk in every respect.

A.226. For the present do you know anything more than the layman knows?—No.

A.227. *Mr. Calvert:* Can dairying education of the Bangalore standard be given in any of the provincial agricultural colleges?—Not at present.

A.228. In none of them?—None of them.

A.229. So that if your education in dairying at Bangalore is closed down, there is nothing at present to replace it?—There is nothing.

A.230. *Mr. Kamat:* Do you think the manufacture of condensed milk in this country is a possibility in the near future?—Yes; we made a trial last week; we have the samples here.

A.231. You think it could be done on a commercial scale in various parts of India?—I have been asked by two of the largest provision firms in India, one of them two years ago and one quite lately, to tell them definitely whether they would be safe in investing money in India in a condensed milk plant as they are large importers and they think they can produce it much cheaper in the country. In view of this enquiry we have purchased a plant, but we have never had any funds to work it. We have had just funds enough to pay for the plant.

A.232. No experiments even on a laboratory scale have been done?—No.

A.233. *Sir Henry Lawrence:* As regards the last question, what funds are there at your disposal for your experiments?—We have had none allocated so far specially for experiments. The budget for the working of the dairy has been utilised to do what little we have done.

A.234. How much does it represent?—I shall have to get the figures. Will you permit me to give them to you later? The net sum of course is much smaller than the budget as we return most of the money we get at these farms, but I will give you the gross and net figures later.

A.235. Can you give me any estimate of the total expenditure you would like to make?—The revenue expenditure at the Bangalore, Wellington and Karnal Farms for the year ending March 1926 was 3,15,182 rupees and for the same period the receipts from these farms were 3,13,655 rupees. A detailed note of expenditure and receipts has been handed over to each Member.

A.236. *The Chairman:* The actual net expenditure is not shown?—No. The revenue expenditure generally is less than the receipts. I will send the figures to you in a statement. (Appendix II, page 47).

A.237. *Sir Henry Lawrence:* All told, the Government of India are not spending out of pocket much more than a lakh of rupees a year?—They are not spending anything like that, on revenue expenditure.

A.238. What do you consider the interests of the country in dairying and improvement of cattle are worth?—You could economically spend a crore with really good results. The Irish Free State this year are building a new dairy

school at a cost of £49,000 and are allotting £6,000 a year to keep it up, and they have only 3¼ million people.

A.239. So that if the Government of India and the Provincial Governments were to spend some crores of rupees, it would not be money thrown away?—It certainly would not; we have got 170 million cattle in the country.

A.240. *Dr. Hyder:* Do you think one research institute would be able to cope with such a vast number of cattle?—No, I do not.

A.241. *Sir Henry Lawrence:* Would you like to increase the number of institutes throughout India to half a dozen or so?—Half a dozen would certainly not be an unreasonable figure.

A.242. Do you know anything of the progress of building up some half-bred herds in Brazil and Texas, for which Indian bulls were imported?—The best known is Mr. Borden's herd in Texas. He had Gir bulls and the cattle he now has are one-eighth Gir. They show distinctive traces of the Gir head and twisted ear in every case. They are superior to the pure European breeds in this respect that they could go further to water and come back without losing flesh. They are bred for beef entirely.

A.243. When was that experiment made?—It began I think about 20 years ago. I sent Mr. Borden his first bull in 1904. He has an eighth part left in a great many of them, but he cannot get in any more bulls. He tried very hard, but the United States Government absolutely refused to allow him. He said the Gir put on beef better than any.

A.244. Why were they not sent?—The United States Government would not allow them to go in.

A.245. A similar success has been achieved in Brazil?—In Brazil they were largely got for breeding purposes, the pure Nellore. There are two very fine herds in Brazil. We published in the *Agricultural Journal* two photographs we had procured for the purpose. There are some 1,800 head of pure Nellore in Brazil; that is in the herd of one man; it is a private venture. He sells bulls for very high prices. They use Nellore, I believe, mostly in the coffee districts and the planters use the cows for milk.

A.246. I am not quite clear about your views on the question of importing bulls and their effect in this country. You say that the second and third cross, 3/4 and 7/8, are not suitable?—No.

A.247. But the experience in Brazil and Texas is to give a cross in the first generation and then continue with other cross-breds I think?—No, Mr. Borden continued with pure-bred bulls. He used pure Shorthorn and pure Hereford. Mr. Borden is far too clever a man to breed with cross-bred bulls. He uses nothing but the best.

A.248. But then he does not keep on with the Gir bull?—He cannot; he would like to do it very much, but they will not allow him to bring them in. The last lot that arrived for him there were, I believe, slaughtered at Washington.

A.249. Then there is no lesson to be drawn from these Brazil and Texas experiments that is of any value to this country?—No. In Brazil, as far as I know, they have kept the Indian breeds pure. In fact the finest Nellore cattle in the world are undoubtedly found in Cuba and Brazil to-day.

A.250. The losses from rinderpest are very severe in this country?—They are.

A.251. To what extent can it be rightly said that the local cattle are immune from rinderpest?—Some are more immune than others, but all of them, except the hill cattle, have a very high degree of natural immunity.

A.252. But how do you reconcile that with the loss from rinderpest?—If they did not have that degree of natural immunity, the loss would be 90 per cent. Probably it is not more than 25 per cent. In the Military dairies before the days of simultaneous inoculation we never lost more than 30 per cent. In one lot of Aden cows we lost the whole lot; they died like flies; they had no natural immunity.

A.253. You mentioned in answer to the Chairman that you regard heredity as one of the important factors in the improvement of cattle?—Yes.

A.254. Is it not the primary factor?—It is.

A.255. I thought you regarded it as one of the minor factors?—Pedigree means that you have the force of heredity.

A.256. *The Chairman:* The witness's point was that heredity is an important factor in resistance to disease?—Yes, it is. That, as proved with the half-breds, is a Mendelian factor. Some of them carry a high degree of immunity to rinderpest, and some of them have no immunity at all.

A.257. *Sir Henry Lawrence:* Amongst the good breeds that can be improved for milk you mentioned the Deccani. I was not quite sure what breed you had in mind. Were you referring to the Krishna Valley cattle?—No. Krishna Valley cattle are the Nellore cattle. I was referring to the Dangi cattle. They are black and white. They breed wonderfully pure. You get them all round Belgaum.

A.258. What do you mean by Deccani?—They are generally called in that district Deccani cattle. They call it Dangi.

A.259. Then, you said that Mr. Keventer was sending milk from Aligarh to Delhi. What distance is it?—It is about 100 miles.

A.260. What do you regard as the best system for the production of milk for Bombay?—Production in the fields in a rural area where you can get all the fodder you need, pasteurisation, and railing it into Bombay. I regard that as the system for all Indian cities.

A.261. Do you know of any particular difficulty in the way of having successful dairies established outside Bombay?—None, except the one great difficulty which strikes at the root of this question of urban milk-supply, the want of protection against impure produce. That is the principal difficulty.

A.262. *Mr. Calvert:* Bad milk drives out good milk?—It is not so much that, but the respectable business man will not invest his money in the dairy industry if he has to compete against every kind of white liquid sold as milk. It is unfair competition and the risk is too great for the capitalist to undertake.

A.263. *Sir Henry Lawrence:* What you draw attention to is the necessity of improving the protection of the purchaser of milk in the cities?—Yes, and of the vendor. The protection of the vendor from the point of view of the dairy trade is really the important thing. The honest vendor now has no chance.

A.264. There are regulations, but they are not enforced?—Yes, standards have been fixed and everything else.

A.265. *Professor Gangulee:* Are they not being enforced in Calcutta now?—Not very well. The Municipality have given half a lakh of rupees to a co-operative society, and that society is going ahead very well because they are selling pure milk, but they complain bitterly of the competition they have to meet.

A.266. Mr. Keventer sells milk in Calcutta and he has good milk?—The quantity of milk he sells is very small. He does not come to the commercial scale. He has the gilt-edged trade which you can get in any community at a very high price.

A.267. *Sir Ganga Ram:* Have you published any pamphlet or book containing the names of the fodders you have experimented on?—I have not experimented on any fodders.

A.268. You say you have experimented on different kinds of fodder?—No, that is Mr. Warth.

A.269. Do the Military Department generally make butter from buffalo milk?—They always make it from buffalo milk.

A.270. What is the difference between buffalo milk and cow's milk?—The proportion of fat in the milk of the class of cows that the Military dairy farms

use may be taken as 4·25 per cent on an average; the percentage of fat in the milk of the buffalo is usually 7·75.

A.271. Is there any physical or scientific objection to the male buffalo being used for draught purposes?—The general experience is, he will not work in the heat which is the time when you want him to work. I have tried him myself in farms under my charge.

A.272. Is he used for drawing carts?—He is a bit slow, but the worst objection is that he lies down when it gets a little hot.

A.273. As far as you know there is no religious objection?—None whatever.

A.274. *Dr. Hyder:* You stated that the buffalo will not work in the heat. Do you know the hours of ploughing in different parts of the country? Do they not begin ploughing at 5 in the morning and finish up by 10 A.M. and plough again in the afternoon after the heat has subsided? If that is so, the question of employing the male buffalo in the heat does not arise?—The buffalo is too slow, and the chief thing for the cultivator is speed. He gets the rain, and he has to get on with his cultivation or it is too late.

A.275. Is that so in the Mysore State?—Yes. He ploughs all day round about here in the season.

A.276. *Sir Thomas Middleton:* Can you give us any idea of the number of pedigree bulls now being produced by the different farms in India?—I cannot say.

A.277. Approximately is it 500 or 5,000?—I cannot say.

A.278. Can you tell us how these bulls are tested? I understand they have short pedigree?—Yes.

A.279. How are they tested? Are they tested at all before being sent out?—The test applied is of course the general size, utility and power of movement.

A.280. Is the quality of their progeny followed up by inspecting officers?—In some instances it is, but generally it is not.

A.281. Can you give me any idea at all as to the number of misfits among these bulls that are sent out?—Amongst the bulls sent out from the Punjab farm, which is the biggest, I do not think there are many. They are very careful about sending them out; there is nothing sent out that is not good; they are not sent out until they are mature. Outside the Punjab comparatively few pedigree bulls have been sent out so far.

A.282. Your scheme is to supply Government pedigree bulls for all the cows of India?—Yes, eventually.

A.283. How many pedigree bulls would you want?—A million. You have got 44 million adult cows, and at the rate of 1 bull for every 50 cows, you need a million bulls.

A.284. I do not know whether you have considered any time table for your scheme or whether you have contemplated a process of 20 or 30 years' development?—It is hardly in the nature of a scheme yet so far as I am concerned. I have only put down the ideal that has to be attained. We have not had the temerity to go into a scheme as yet.

A.285. Would you agree with me that to reach that ideal it would take many years?—It certainly would.

A.286. Would it be measured by years or centuries?—By years. It has a cumulative effect, you see. Every bull you get out is good for 50 cows per year. I am thinking of what has been done in Ireland since they started the premium bull system. They have revolutionised the cattle in the south of Ireland in 20 years.

A.287. I can remember what the cattle of Ireland were 40 years ago and I know them now, and I recognise that they have revolutionised the cattle there. But the Irish had a stock to draw upon which had been bred for 150 years?—Yes. They drew upon England. They had a pedigree to draw upon, but we have not got that.

A.288. I have been thinking of the improvement in Ireland and I have been asking myself how long it would take to have a similar change accomplished in India with no pedigree stock to draw upon?—I have never thought of the point. However long it is going to be, it has got to be done.

A.289. I think you will have to reckon in centuries and not in years?—I hope not.

A.290. You take rather a pessimistic view of private enterprise. You think it is hopeless to expect private enterprise to do anything?—So far it has been so in India.

A.291. Because it is unprofitable?—Yes, you see the rejection question is so difficult. Everybody I have talked to about it has asked me, "What are we going to do with the unfit?"

A.292. Was it hope of profit that encouraged private enterprise in England?—Yes.

A.293. How many landowners in England made profits out of cattle-breeding?—It was the tenant farmer who developed cattle-breeding in England.

A.294. He bought the cattle?—Yes.

A.295. But who bred them?—He bred them himself. Most of the great breeders that I have known were tenant farmers. There was Mr. William Duthie of Collynie. Where would you find a more public-spirited man, and look at the vast fortune he left as the result of this work.

A.296. But if you will look through the history of pedigree breeding in England and in Scotland I think you will find that landowners and private enterprise were at work for a very long time before the tenant farmer began to take up pedigree breeding?—The landowner was at work, but would you not admit it was a profitable thing for him? He was a public-spirited man no doubt, he wanted to make his tenants more successful; he felt that this was too big a job for them in the beginning and so he took it up; but in the end it was profitable for him. It was certainly profitable for his tenants, and that meant he would get his share in the end.

A.297. If you apply ordinary profit and loss methods to the account of landowners you would seldom show a profit on pedigree breeding?—I am not acquainted with that aspect of it.

A.298. It was private enterprise that made the stock of Great Britain?—But is not private enterprise in all countries actuated by a desire for profit?

A.299. *The Chairman:* Or public spirit?—The enterprises of most of the business men I have met aimed at making money in the end.

A.300. *Sir Thomas Middleton:* It was from that point of view, that I thought perhaps you were taking a narrow view of the possibilities of private enterprise among the landowners of India?—Probably I am not sufficiently acquainted with the subject, but that was my opinion. The men whom I have personally known, most of whom have been in Scotland, were tenant farmers who were interested in cattle-breeding and they made money on it.

A.301. Some of them do. I could mention some who do and some who do not?—I think I am correct. I think they did make a profit.

A.302. To go to the other end of the scale of breeders, I think you are a little too hard upon the *Rabari* of Gujarat. You put down the lack of improvement in Indian cattle mainly to the ignorance of the cattle-breeder and you mentioned in an answer in that connection that the *Rabari* was now a fodder thief. I find, however, that you have a good impression of their knowledge of stock. Do they not care for their stock?—They probably care for the stock, but they cannot get sufficient fodder.

A.303. Is that not an excuse for them becoming fodder thieves?—But it does not contribute to the improvement of the cattle.

A.304. It keeps the cattle alive?—It would be better if they were dead, if they cannot be properly fed.

A.305. That brings me to the next point, the question of fodder. I think on page 12 you sum up the position in a way with which I agree. You say

this question will only be solved when it can be made profitable for the cultivator to rear cattle?—That is what we have got to aim at. We are trying to make it profitable.

A.306. What amount of produce would you require, in your opinion, to make the rearing of a cow profitable?—Two thousand five hundred pounds of milk a year per cow.

A.307. You will agree that the actual yield would vary very widely in different parts of India. 2,000 lbs. might be profitable in one part of India, while 3,000 lbs. would be required in another part?—The conditions would affect it of course.

A.308. What is the root condition?—The root condition is the quality of the animal, its capacity for producing milk. It is the degree of efficiency of the milk-producing machine, namely, the cow.

A.309. In connection with your point that the cultivator must go in for growing food, would the cost of production of his fodder be an important factor?—I have always contended that the shoe is rather on the other foot. He will not grow fodder, because the animal to which he has to feed it does not produce anything in return. That is what I have seen in this country at the shows where I have judged. You will always find in big areas like Central India, the bullocks that produce a return for their food are fat as butter, but the cows are not fit to be looked at. The cultivators say, "What does the cow give us in return?"

A.310. That is just the question I was going to ask you. Supposing a cultivator puts you that question in some particular tract, you would be able to say to him, "Well, a cow that yields you 2,000 lbs. brings you nothing, but a cow yielding 2,500 lbs. yields a profit"?—Yes, there would be something in that.

A.311. *Sir Ganga Ram:* What about the manure?—They say they keep them for manure.

A.312. There ought to be some credit given for the manure he gets?—You do not mean to say that the manure that the animal gives is sufficient return for his food?

A.313. No, but when you say that it gives no return you have to take that into consideration?—It is of value.

A.314. *Sir Thomas Middleton:* After that limit is reached, we will call it 2,500 lbs., the profit increases very rapidly?—The ratio goes up very rapidly.

A.315. Have you in any case issued information or bulletins showing how the rate of profit rises with the increase in the yield of milk?—I have not.

A.316. Has that been done in India to any extent?—I have not seen it.

A.317. The attention of the cultivator has not been drawn to what one may call the marginal limit in milk production and the rapid increase of profit after that margin has been passed?—I think not.

A.318. Now, we have been talking a great deal about the bull, but have said very little about the Indian cow so far, except to condemn her milk-yielding qualities. Is it not your experience that even among the Indian cows there is a very large individual variation?—Yes.

A.319. If you went into a district, such as any of those you have named, where there are good cattle, and were to select 100 cows, what percentage of those which you bought by inspection would you expect to turn out really profitable cows?—I have never bought any cows for these farms that were not profitable. All of them have been profitable.

A.320. That is pretty good testimony to the average quality?—Yes, but you could get very few, and in some districts you could not get any that were really worth buying from that point of view.

A.321. You mentioned in reply to Sir Henry Lawrence the Gir cattle. What sort of percentage would you expect with that breed?—You would probably get about 20 per cent of them pretty good, but there are a very small number of them left, and what is left are fairly good.

A.322. It happens that 20 per cent. is the percentage I got when I secured a herd of the Gir breed many years ago?—Yes, but you can hardly get them at all; it would take you three weeks to pick up a dozen.

A.323. If you were buying in Sind or in any other district where the cows are good, what sort of percentage would you expect to get?—I could pick up in Sind as many as I want, all good. I bought 3,680 for the Military dairies in Sind in 2½ years during the war and practically every one of them was good.

A.324. Can you give us some idea of the variation of yield?—2,500 lbs. to 5,000 lbs.

A.325. One would call a cow yielding 2,500 lbs. a good cow?—Yes, but Sind is an exception; you can still get plenty of good cows in Sind, but there is no other place that I know of in India where you can do that.

A.326. *Sir Henry Lawrence:* Any Karachi breeds?—Of the 3,680, there were about 250 of the Thar Parkar breed, and all the others were red Sindhi or Karachi breed.

A.327. *Sir Thomas Middleton:* In most districts in India, one could still find a small percentage; the quality remains in the individual cows in most districts; does it not?—No, not in many districts. In North Arcot I was judging at a show last year; there was not an animal in the show that we would have bought.

A.328. Not an animal giving more than 1,500 lbs.?—There was no animal giving 1,000 lbs.

A.329. On page 7 you set out the problems that you would like to take up?—Yes.

A.330. These are not arranged in any order of merit, are they?—Not particularly; I think myself that No. 1 is certainly the most important.

A.331. There is an enormous demand for *ghi* in the country?—Yes, and an extraordinary amount of adulteration takes place in connection with *ghi*.

A.332. The errors in the manufacture of *ghi* are mostly wilful. People know how to manufacture *ghi* very well, if they wish to?—Throughout the country they adopt one method; there is very little variation; my own opinion is that it is a very wasteful method.

A.333. *Dr. Hyder:* Have you ever seen Kashmere *ghi*?—I have seen it on the market.

A.334. Does it smell?—It smells high.

A.335. *Sir Thomas Middleton:* I understand that for sometime there was a large trade in casein in Gujarat?—There was.

A.336. What has become of that trade?—There is very little done now. It has such a bad name that the people in London will not buy it, or at least they do not look for it. It is too much adulterated, and it contains fat and rice meal very often, always butter fat; it is not properly washed out.

A.337. You mentioned that you have been consulted with reference to laws that were introduced in three Municipalities?—Yes, the three Municipalities wrote to us at one time or another.

A.338. What percentages of butter fat in milk are stipulated?—5 per cent for buffalo's milk I think, in all three cases, and 3·25 per cent for cow's milk as the standard minimum; 8½ per cent solids, not fat, in both cases.

A.339. You had a sufficient number of analyses at your disposal to enable you to fix these standards without much difficulty?—We had no difficulty at all; we had plenty of material; you see, they wanted a standard that would be within a safe limit.

A.340. *Professor Gangulee:* You test butter fat by the Babcock method? —By the Gerber method; it is the simpler method. The Babcock method is used in America, but it is the same principle.

A.341. *Sir Thomas Middleton:* I gather from your replies to other questions that the difficulty is not your lack of knowledge as to what the milk

ought to contain nor is it due to the absence of legislation, but to the lack of enforcement of legislation?—That is so.

A.342. Do any prosecutions take place?—Yes, there are a few which take place in all places.

A.343. Are the fines negligible?—No; I do not know what they are now. They are not too low; they are fairly severe.

A.344. Is there imprisonment for repeated offences?—No; no imprisonment.

A.345. With reference to the incidence of rinderpest, can you say from your own knowledge whether rinderpest attacks the weakest cattle on the grazings, or whether it attacks indiscriminately the better kept and the poorer animals as well?—I think our experience of rinderpest on the Military dairy farms is that it attacks the poorest, and those that are in bad health are more likely to be attacked than the others.

A.346. You argue that there are far too many cattle in India, and therefore rinderpest may not always be an unmitigated evil?—Unfortunately, as the years go by, of course they gain a greater degree of immunity to rinderpest. Every generation is a little more resistant than the other.

A.347. *Professor Gangulee:* Your pure breeds are comparatively immune from rinderpest?—No; most of them are not immune, but we get some which have an immunity, which is evidently a Mendelian character.

A.348. *Dr. Hyder:* You say that your charge is the whole of India, including Burma. I want to know whether that is a small charge or a big charge?—It is a big one.

A.349. You think there is room for provincial institutes?—There certainly is.

A.350. Is yours a research institute, or what?—We have done practically no research so far. It is educational up to the present, and experimental to some degree.

A.351. It is only an educational institute, you say?—Yes.

A.352. You give a Diploma course?—Yes; we take also post-graduate students and short course students.

A.353. You admit there is room for many more such institutes in all the Provinces in India?—I think there is.

A.354. You have mentioned some of these problems which are awaiting investigation?—Yes.

A.355. Do you not think any one of these problems is enough to occupy the lifetime of one man?—It would certainly occupy a great deal of his time if he went to the end of it; there is no end of course in that sort of thing.

A.356. I suppose you would admit that behind these problems there are other problems connected with fodder and things of that sort?—Yes. You see, in regard to these problems it would not take a very long time to get sufficient information to be able to give the data to the country and indicate which is the best method of doing this or that, and which is the best method of avoiding loss in doing it. For instance, this throwing away of the by-products of *ghi* must mean an extraordinary loss to the country.

A.357. You refer to the butter-milk; do you not?—Yes.

A.358. Is not that drunk largely by the peasants?—In some parts it is; at certain times of the year when milk is scarce they drink it; at other times when milk is plentiful it is partly thrown away.

A.359. My experience of the Punjab is that in the winter season they make it into some sort of soup and they drink it in large quantities. Is that so?—Yes.

A.360. Are there other parts of the Empire in which such research people are investigating these problems?—No. There is no part of the Empire where they are investigating the problem of the treatment of the milk of the buffalo. It is the milk of the buffalo that we have to deal with now. *Ghi* is nearly always made from the milk of the buffalo.

A.361. I think your great problem is to evolve dual purpose breeds?—Yes; we must deal with the conditions as we have them.

A.362. Do you think you can get any assistance from such workers in other parts of the Empire?—No; we have to deal with these problems on our own; our conditions are different.

A.363. Can you get any help from Australia or Canada?—We get all the information they can give; but the particular question we have to tackle here is the question of buffalo milk. All the literature that we get from them refers to cows' milk.

A.364. Take the question of storage?—That is a tropical question. There is very little done under tropical dairying in any part of the world. Most of the great dairying countries that have gone ahead have been in more or less temperate climates.

A.365. *Sir Thomas Middleton:* With regard to dried milk, it is to be an investigation of the costs, I take it?—Costs and methods.

A.366. You would not use a drying roll?—It all depends. I should try the vacuum roll. I think we should get the best results here by spraying the milk into a hot chamber. There was a factory which worked on that system in Gujarat for a while, but it was allowed to fall to pieces after the war. They made a lot of it which sold very well in Europe.

A.367. The investigations are mainly of a commercial kind; you want to go into costs?—Costs and methods, and find out also what kind of stuff we can produce for the world's market. Our casein nobody will buy.

A.368. *Sir Ganga Ram:* Is there a milk factory in Mysore?—I understand Sir Alfred Chatterton is going to do something; but he has not done anything yet. There was one started in Gujarat. They put up a magnificent plant, but never made a tin of condensed milk.

A.369. *Professor Gangulee:* What are your views regarding the export of cattle?—I think myself we should encourage it for all we are worth. That is the one thing that will bring home to our people the value of pedigree. It will raise the value of cattle. A lot of Sindhi cattle are exported now; a small export trade takes place now.

A.370. You would not put a stop to it?—Certainly not.

A.371. You do not think that is a drain on the country?—No; not at all.

A.372. *Dr. Hyder:* Is this export trade in livestock or in meat?—In livestock.

A.373. You think it is a large volume?—No, it is a very small volume; it will be well to increase it.

A.374. *The Chairman:* Do you think the export of pedigree animals from Great Britain has been the chief cause of the improvement of the cattle in Great Britain?—I do, and in Holland.

A.375. *Professor Gangulee:* You said you would not have legislation with regard to the spread of cattle disease?—Not at present.

A.376. Have you any idea what effectual steps could be taken for the control of infectious disease?—The only effective step would be restriction on movement; but we cannot do that until you have an organisation fit to enforce it.

A.377. You must create an organisation?—Yes, you must have your organisation first, so that when you pass legislation it will not be a farce.

A.378. You suggest that you would like to have a number of dairy institutes all over the country?—I said there was room for them.

A.379. In the event of your having these dairy institutes all over the country, would you have them one in each Province, or would you divide the country according to the so-called dairy tracts?—As a matter of fact, the major Provinces, I think, would start one each; the smaller Provinces would probably utilise that belonging to their nearest major Province.

A.380. You would keep in view administrative units and not suitable dairy tracts?—I think myself that the whole country requires dairy produce, and it all requires cows. In the backward districts it is more important.

A.381. I was speaking of areas where the conditions might be favourable?—I do not think there is any part of India that could afford not to develop the dairy business, not only from the cattle point of view but from the point of view of the well-being of the people.

A.382. In England one should certainly have dairy institutes in Norfolk or Suffolk. But the National Institute of Dairying is located at Reading?—You are dealing with a very much more confined area there.

A.383. Gujarat, as you say, has very favourable conditions for dairying. Would you not like to have an institute there?—That is why I am so anxious to keep this factory there.

A.384. It would be desirable to have an institute in Bengal?—Yes.

A.385. If you had these dairy institutes, who would be the controlling agent? Would it be the Government?—If they were provincial, I take it, as things are now, they would be controlled by the Provincial Government.

A.386. If you establish a dairy institute on the basis I suggest you could get better advantages. Then it would not be in the jurisdiction of any particular Province?—It might not be; it might be run by the Central Government, and run with great advantage, I believe.

A.387. Then you would have, for example, a number of institutes just like this Institute of Dairying under the guidance and control of the Central Government?—It would be a good thing, I think.

A.388. *Mr. Calvert:* Do you think you could produce a dual purpose animal for the whole of India, or would you find difficulties invariably in the sub-montane and montane areas where you have these little terraced fields for which a very compact animal is required? Does that mean that you cannot get a dual purpose animal?—I see no reason why the dam of that bullock should not give a reasonable quantity of milk.

A.389. What about your rejection of the Dhunni breed?—I took an opportunity of studying that breed; I think we could introduce milk into it.

A.390. A dual purpose policy could not be extended throughout?—It could.

A.391. *Sir James MacKenna:* Have you attended the meetings of the Board of Agriculture?—Yes, since 1909.

A.392. What do you think about the scope and utility of that body? Can it be made more useful than at present?—I think it served a very useful purpose, a very great purpose indeed. I have enjoyed the meetings so much and obtained great assistance and benefit from them. I think it might be extended with benefit to the country very largely. It is the only point at which the members of the Indian Agricultural Service have an opportunity of meeting one another and of getting new ideas and of having their own ideas criticised. I say that the Board of Agriculture has done great work for agriculture in India, and I should be sorry indeed if it were dropped. I believe it could be extended and enlarged, to the benefit of the country.

A.393. Have you any suggestions to make in that respect?—I think myself that it could be enlarged as a general Board, that is, a Central Department, working through expert executive committees. That ought to make it less unwieldy, and probably take up a little less time.

A.394. *Sir Henry Lawrence:* You have mentioned one point on which you disagreed with the views and opinions expressed by Mr. Bruen. Are there any other points in Mr. Bruen's evidence which you think it necessary to explain or say something about?—There is one point. He stated that if the Military dairy farms had done at every farm what they have done at Ferozepore, and built up a pure Indian herd at each farm, as they have done at Ferozepore, the result would have been the same to them; meaning thereby, I take it, that we would have had their milk equally cheap and in addition have been able to contribute largely to the cattle-breeding policy of this coun-

try. I entirely disagree with that. To begin with, the Ferozepore herd was founded by taking the best cattle from all the herds in India, and that could only be done once. Secondly, Mr. Bruen quoted the fact that the average yield of the present herds at Ferozepore was practically as high as that of some of the cross-bred herds. That may be so, but it has taken 17 or 18 years to bring it to that point, and you had this equally high yield from the cross-breds in about 4 years, so that in the intervening period between the 4th and the 17th years the Military dairies would have lost a very large sum of money in the production of milk. That is a point on which I disagree with him.

A.395. Are there any other points of importance on which you disagree with Mr. Bruen?—I again entirely disagree with the statement made by Mr. Bruen that half-bred bulls sold or otherwise distributed by the Military Farms Department in India have injured the quality of Indian cattle and have introduced diseases amongst them. As a matter of fact practically no uncastrated cross-bred males were issued or sold by the Military Farms Department and very few cross-bred cattle of any kind were disposed of to the public by the Military Farms Department during the 15 years of my service with them, so much so that it is quite impossible that the few animals sold to the public could make any impression whatever on either the health or the quality of the cattle of India.

A.396. With regard to the milk-supply for cities, are you satisfied with the facilities which the railways give for the carriage of milk to cities?—My experience of the railways has been really very good. In War time, we sent enormous quantities of milk. We sent milk from Jubbulpore to Bombay and sold it there. I found the railways were very ready to meet us. They generally arranged a special rate, especially the Bombay, Baroda and Central India Railway.

A.397. Do you think they will meet the private producer in the same way?—I could not say. They put a special van on the Bombay, Baroda and Central India Railway to enable us to send milk to Bombay; we could only guarantee the traffic up to the end of the War.

A.398. Is it in existence now?—I do not know. We did not do it after the War.

A.399. *The Chairman:* You have mentioned the desire on the part of foreign countries to import into those countries the best native breeds. Have you looked round the tropical world to see whether you could find any animals which may improve the Indian breeds?—I have never had the opportunity of visiting the tropical world to see for myself. From all I can learn from correspondence, we have been carrying on correspondence for a great many years, they have nothing as good as we have.

A.400. How about Ceylon?—They use Sindhi cows very largely. There is a regular business there in Sindhi cows. I have myself bought some cows for the Government of Ceylon and shipped them. I had been to Ceylon last year, and I found they had very poor cattle.

A.401. Are you devoting any time to the improvement of the buffalo as a milk-yielding animal?—We have on our farm a small herd at Karnal, and we have a few here; but you can buy in the open market. If you go to the right place, you can buy good buffaloes to-day. That is not the present problem.

A.402. Is the practice of sending she-buffaloes in milk to, for instance, Bombay, milking them until they dry, and thereafter selling them, having a bad effect on the breeds?—It is done systematically and regularly. I do not think it has had a very serious effect on the breed.

A.403. Do you think it may have that effect in time?—I doubt it; it is hardly big enough to affect it.

A.404. Mr. Bruen told us that the difference in the melting point between the butter of the buffalo and that of the cow is a practical factor in its popularity?—Mr. Plymen, the Director of Agriculture in the Central Provinces,

when he was Agricultural Chemist to that Government, made some very careful investigations into the subject, and he found that the melting point varied of course at different seasons of the year, from 7 to 9 degrees Fahrenheit. He published a pamphlet on the subject, which is available.

A.405. Which has the higher melting point, the butter of the buffalo or of the cow?—That of the buffalo is higher; it stands up much better to the heat.

A.406. Which is the better for cooking purposes?—That of the buffalo is better.

A.407. To revert to the question of draught animals, is hardness of the feet a very important quality of the draught animal?—It is an important quality.

A.408. Are you watching it here?—As a matter of fact, in our crossing experiments in the Military farms, we have not paid any attention to draught whatever. In the selection of cattle for dual purposes here, we have paid particular attention to the feet, but we have not had any trouble. The breeds that we have taken up have good hard feet.

A.409. Is it the case that in parts of the country which are hard and stony, they evolve an animal with very hard feet?—I think it would naturally be so. I have not found that the Sindhi, which has been bred in the northern part of India, has any better feet than the Hariana of the Punjab. They are both shod of course when they come to work.

A.410. At the very end of your memorandum you make a complaint against the Railway Companies, because they charge for the calves running with the dams at the same rate as they do for cows themselves?—They do so for passenger trains.

A.411. Have you ever made a complaint about it?—I took the matter up with the Government of India; Dr. Clouston took it up with the authorities; the correspondence lasted for a year and a half, but nothing came of it.

A.412. What did they say?—They said those were the rules, and they refused to give a refund. On a goods train, you may have your calves that are under 2½ feet high at the shoulder free, but by passenger train you have to pay the full charge for the calf. And according to their own rules not more than 8 can be put in a wagon, yet they put 16 in a wagon, including the calves.

A.413. Do you get an impression, from your long experience of India, that, taking one thing with another, the rural population is anxious for an improvement in the cattle-breeds?—I think they are, the better class of them. The poorer class breeder in the jungle tracts is really too ignorant; he is too much of a jungli to understand what it means, I think. But the breeder of the future must, I think, be the cultivator; he is certainly ready for the scheme, would welcome it, and would assist in bringing it about.

(The witness withdrew.)

APPENDIX I.

A.—Principal dual purpose breeds (types) of cattle (non-buffalo), in India.

Name of breed.	*Habitat.*
Sindhi	Western Sind.
Thar Parkar	South-eastern Sind.
Hariana or Hansi Hissar	South-eastern Punjab and parts of the United Provinces.
Ongole or Nellore	Guntur district of Madras.
Kankrej	Gujarat district of the Bombay Presidency.
Gir	Kathiawar and parts of Baroda State.
Krishna Valley	These are Nellore cattle bred in the Krishna Valley district in the Bombay Presidency.

B.—Principal single purpose breeds (types) of cattle (non-buffalo), in India.

Sahiwal (Montgomery)	Milk, Central Punjab.
Dhunni	Draught, Northern Punjab.
Bhagnari	Draught, Baluchistan and Northern Sind.
Kheri	Draught, Northern United Provinces.
Malvi	Draught, Central India.
Nimari	Draught, Central Provinces.
Khillari	Draught, Khandesh and North-eastern Bombay.
Dangi	Draught, Southern Maharatta country and hilly tracts of the Deccan.
Amrit Mahal	Draught, Mysore, South-eastern Bombay and parts of Madras.
Kangyam	Draught, Central Madras.
Burmese	Draught, Burma.

APPENDIX II.

Statement showing the Expenditure and Receipts of the three Farms at Bangalore, Wellington and Karnal and of the Office of Imperial Dairy Expert for the last three years.

	1923-24. For 9 months only (July—March).			1924-25.			1925-26.		
	Total revenue expenditure.	Total receipts.	Capital expenditure.	Total revenue expenditure.	Total receipts.	Capital expenditure.	Total revenue expenditure.	Total receipts.	Capital expenditure.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Imperial Institute of Animal Husbandry and Dairying, Bangalore.	1,09,840	1,17,599	58,093	1,55,294	1,76,001	34,740	1,41,380	1,51,391	32,460
Imperial Government Dairy Farm, Wellington.	58,714	70,312	15,975	79,109	86,408	8,918	87,785	83,913	18,195
Imperial Government Cattle-breeding Farm, Karnal.	27,014	75,211	77,947	68,079	71,918	44,371	86,017	78,351	28,407
TOTAL	1,95,568	2,63,122	1,52,015	3,02,482	3,34,327	88,029	3,15,182	3,13,655	79,062
Office of Imperial Dairy Expert	46,585	...	...	38,392	...	...	43,531	...	...

Mr. F. J. WARTH, Physiological Chemist, Bangalore.

Memorandum on the Animal Nutrition Section, Bangalore.

1. *History of the Animal Nutrition Section.*—The New Section dealing with Nutrition was started by me on October 24th, 1921, at Pusa. The initial work consisted in training a staff, testing methods of analysis, methods of sampling and the entire routine for digestion experiments. Trial stalls were set up and tested for their suitability in this country. After this preliminary work, land was procured and levelled, digestion stalls with the necessary adjuncts were constructed, and a series of digestion experiments was undertaken. A new form of nitrogen metabolism apparatus was devised by me at this time. The apparatus, which has been described in the *Agricultural Journal of India* (Volume XVIII, Part 3), was put into operation at Pusa and yielded some very interesting results. It was found, for instance, that the Bihar bullock maintained a nitrogen balance with a remarkably low proportion of protein in his ration. These and other results emphasised the need for studying the applicability of European standard rations to Indian cattle. The results of one year's work at Pusa were that preliminary tests had been completed, a temporary but efficient block of nutrition buildings had been set up, a satisfactory routine for digestion work had been established, and experiments were proceeding without a break. In addition to this the new nitrogen metabolism apparatus was in operation almost continuously. Some of the results obtained with rice straw in this early work were published in the *Agricultural Journal of India* (Volume XVIII, Part 5). Digestion experiments were also carried out with a number of concentrates from Government Military Dairies. I went on leave in April 1923 and Mr. A. V. Iyer, First Assistant to the Physiological Chemist, took over charge. The work proceeded smoothly until July 2nd when orders were received to transfer the Section to Bangalore. The transfer was effected efficiently and promptly by Mr. Iyer and on my return to duty in November 1923, I was posted direct to Bangalore. It became evident on my arrival that, if anything, the transfer had been too prompt. There was no laboratory and there were no stalls. The proposed laboratory was inadequate. Fresh plans were prepared and construction of the laboratory and stalls pressed forward. By great exertions and by working in half fitted rooms chemical analysis was commenced at Bangalore in July 1924. The transfer had, therefore, cost the Section exactly one year.

2. The following is the working accommodation provided at Bangalore for the Nutrition Section:—

(*a*) A chemical laboratory fitted up in a building which was originally a dairy store house. It includes a lecture room for the Dairy Diploma students, a store room and office rooms occupying 1,632·8 square feet. The laboratory rooms proper occupy 2,421 square feet.

(*b*) A new cattle shed occupying 1,200 square feet, specially constructed for nutrition experiments.

(*c*) Specially constructed store and preparation rooms occupying 900 square feet, for nutrition work, and adjoining the nutrition shed.

(*d*) A weighbridge brought from Pusa and housed in a specially constructed shed.

(*e*) A petrol gas plant in a small room specially built to accommodate it.

Last year a small extension was added to the laboratory and this year a barn and cattle shed have been sanctioned.

3. *Staff.*—The Physiological Chemist's staff consists of:—

One Senior Assistant, Class II Service.

Three Junior Assistants.

One Fieldman.

One Clerk.

4. *The present system of recruiting staff on long-term agreements.*—I have been fortunate in my staff. Every man has worked loyally. Without devoted service it would not have been possible to carry out the immense amount of work which has been done in such a short time. In considering terms of recruitment it is my opinion that assured employment and definite prospects for good work will bring us more suitable men than we can hope to get in any other way. The primary selection must naturally be done carefully and the probationary period must be long enough to serve the intended purpose. Prospects of promotion on the one hand and the loss of increments on the other ought to be sufficient incentives generally to maintain efficiency in the service. There will be black sheep at times, but on the whole I would prefer to have a staff of permanent men interested in their vocation and their institution and assured of steady employment and advancement.

5. *The work of the Section at Bangalore.*—In commencing the study of Animal Nutrition in India the first question which had to be considered was what lines of work should be taken up. Some of the problems which have been met in other parts of the world are undoubtedly important in India. One of these, the mineral problem has been taken up without hesitation as certain to lead to useful results. There are also problems which are peculiar to the country and the climate. A few of these are obvious. There can be no doubt, for instance, that the coarse fodders require investigation. But we have no assurance that the obvious problems include the most vital. Hence the second question arises. How are the real needs of the country to be tracked down systematically? This can only be done by carrying out numerous feeding tests and procuring first-hand knowledge of the nutritive effect of all kinds of Indian foodstuffs. Experience with a wide range of materials and data for comparative purposes will reveal the requirements. The guiding principle at Bangalore is, therefore, the collection of wide experience. The Section has carried out as many feeding tests as possible wherever and whenever an opportunity offered. The tests have been done invariably with a definite limited object in view and corresponding definite information has been gained; but there has been always behind these tests the general idea of a search for more fundamental problems. It will be seen, in what follows, that the procedure has been completely justified. Already at this early stage of the work matters of wide significance are emerging from these initial experiments. The Section made a start at Bangalore in July 1924, when the laboratory was able to commence analyses. The lines of work which have been developed since that date are described under the following heads.

(*a*) *The testing of feeding standards.*—As nothing whatever was known about our foodstuffs the first experiments undertaken at Bangalore were tests to determine the applicability of European and American standard rations to this country. Tests dealing with milk production and the growth of heifers have been carried to a conclusion. The results have been prepared for publication and will be issued shortly as Memoirs of the Department of Agriculture. The main facts elucidated so far may be condensed into a few words. It was found that the American digestion data could not be applied without modification to our rations. The experiment with our cross-bred cows showed that they were slightly more efficient in the utilisation of food than pure-bred American cows. The higher efficiency is accounted for by a better digestion of fibre.

Eckles in America has shown that the energy value of the milk produced by a cow is greater than the net energy of the food available for milk production, *i.e.*, food is more economically used for milk production than for maintenance or growth. The Bangalore tests confirm and amplify this conclusion. The figures of Eckles in America and the Bangalore results are shown together in the accompanying chart [Appendix III (*a*)]. The work on milk production necessitated a large number of milk analyses. The accompanying graph [Appendix III (*b*)] shows how closely the Bangalore Dairy milk corresponds to average figures from America. Experiments on growing heifers showed that our cross-bred animals required somewhat more net energy for growth than is allowed by Armsby's standard. Compared with the Wolf Lehmann standard they utilised the standard amount of crude protein and somewhat less than the standard amount of total nutrients. The long series of valuable digestion data obtained in the course of these experiments cannot be quoted here. More work on Sindhi cattle remains to be done.

(*b*) *The rationing of young stock.*—The work with young stock is important for a number of reasons. Considering first the animals themselves—they have not developed their digestive systems and require special food on this account. Then the food should be of such a nature that it will act favourably upon the development of a good digestive system. Finally the young growing animal requires relatively speaking an enormous amount of nutrient to support the demands for growth. This must be provided by the food in suitable form and proportions. Economically the feeding of unsuitable or insufficient food results in very serious loss. It involves a great waste of foodstuffs on unproductive maintenance, a waste of the animal's capacity to utilise food productively and a waste of health or ability to resist disease. In studying foodstuffs the young animal is especially useful. The demands for growth being more rigorous than the demands for maintenance, the shortcomings of a foodstuff tell more quickly and more decisively with young stock. For these reasons the Nutrition Section is constantly increasing its work on young stock.

An interesting and useful experiment with calves was concluded four months ago at Bangalore. The animals were divided into three groups receiving different types of concentrates which contained, respectively, A13·9 per cent, B26·9 per cent, C30·3 per cent, protein. The quantities fed were so selected that the net energy provided by the concentrates A and B were equal whilst the protein content of B was much higher. Ration C provided more protein but less net energy than rations A. Roughage was given *ad lib.* The amounts of concentrates fed and the growth obtained are shown in the following table.

TABLE 1.—*Showing amounts of concentrate given and live weight increases obtained.*

	Ration A.	Ration B.	Ration C.
Total concentrate fed per 1000 lbs. live weight.	21·3 lbs.	16·0 lbs.	10·7 lbs.
Protein supplied in concentrate per 1000 lbs. live weight	2·97 „	4·31 „	3·25 „
Net Energy supplied in concentrate per 1000 lbs. live weight	11·49 „	11·49 „	10·70„
	Therms.	Therms.	Therms.
Average daily increase per 1000 lbs. live weight	5·72 lbs.	5·43 lbs.	4·39 lbs.

The figures show that with these rations growth is not proportionate to the protein but runs more nearly parallel to the net energy of the concentrate. The fate of the food protein is shown in the following data obtained from a nitrogen balance experiment with six of the calves.

Mr. F. J. Warth.

TABLE 2.—*Nitrogen balance experiment with six calves.*

Grams per day.	Ration A.		Ration B.		Ration C.	
	Calf 1.	Calf 2.	Calf 3.	Calf 4.	Calf 5.	Calf 6.
Total Protein Nitrogen in ration	53·42	56·50	95·05	68·60	78·14	55·77
Nitrogen digested . . .	32·88	34·22	67·33	49·36	51·84	36·01
Nitrogen excreted in urine .	14·23	13·36	48·66	30·31	35·90	24·02
Nitrogen retained for flesh formation	18·65	20·86	18·67	19·05	15·94	11·99

In ration A the amount of nitrogen digested is low but excretory losses are also very low and hence the balance retained is satisfactory. In ration C the amount of nitrogen digested per 1000 lbs. live weight is much higher but the retention is less perfect. In these experiments, as already stated, roughage was provided *ad lib*, but the actual amount consumed daily by each animal was accurately determined. The roughage consumption together with other significant figures is given in the following table:—

TABLE 3.—*Average daily consumption of dry matter in lbs. per 1000 lbs live weight.*

——	Average Live weight lbs.	Daily increase per 1000 lbs. Live weight. lbs.	Food consumed per 1000 lbs. live weight.			Amount of roughage to 1 of concentrate.	Per cent. digestion of ration.
			Roughage.	Concentrate.	Total.		
A Ration .	218	5·72	10·83	16·25	27·08	·781	59·8
B Ration .	217	5·43	13·02	13·06	26·08	1·130	60·6
C Ration .	207	4·39	14·84	8·68	23·52	1·899	60·0

This table contains important information. The figures show in the first place, as was to be expected, that high allowance of concentrate is accompanied by low consumption of roughage and *vice versa*, that the highest total consumption occurs when concentrate is high and that the live weight increases run parallel with the total consumption. The last fact is especially significant. It appears that the total amount of organic matter digested and the percentage digestion are very important measures of the actual value of a ration, and that the proportion of protein may vary within wide limits without influencing the rate of growth. The actual quantities of food consumed and growth obtained in this experiment are expected to be valuable guides to the practical dairy cattle feeder in this country. The results in suc feeding tests however depend very much upon the nature of the roughages employed. More experiments on these and similar lines are required to determine suitable concentrate allowances for the various roughages. It is proposed to deal with this subject more systematically when the entire Bangalore Dairy herd can be exploited for experimental purposes. That the roughage (sorghum silage) used in the above experiment was of high quality is shown by the figures in the two last columns. The digestion attained remained at the same level when the proportion of roughage was more than doubled. The experiment is finally of interest in showing what can be accomplished with ordinary Indian foodstuffs. A consumption of 27 lbs. of dry matter per 1,000 lbs. live weight by Indian stock weighing 200 lbs. is good, and the growth obtained, over a pound a day per head for a period of 100 days, is encouraging. It should be mentioned, however, that all the animals referred to in this experiment received a mineral supplement to their ration. This point will be dealt with later.

(*c*) *Indian coarse fodders.*—Under this head it is intended to carry out a systematic study of the chief Indian roughages. We possess a certain amount of information concerning our concentrates. We can assign fairly definite

food values to very many of them. With the Indian roughages the situation is altogether different. We do not know the elementary facts regarding their digestibility, energy value or other characteristics. Further, as the roughage forms the bulk of the ration, malnutrition and nutritional diseases almost invariably arise from deficiencies in the roughage. The enquiry on coarse fodders is, therefore, an urgent matter. The tests which have been adopted for this work at Bangalore are rigorous and searching. The experimental animals are kept on the ration for a long period and at different stages of the feeding tests digestion experiments and nitrogen metabolism experiments are carried out.

The first series of tests were made with rice straw and Indian baled hay. The experiment came to an end recently and has yielded most interesting information. Accurate digestion data have been procured and the net energy values of the two roughages have been determined indirectly. It was found that our rice straw has a decidedly higher net energy value than that assigned to the American product. The hay was inferior to average American hay.

These figures will be of the greatest use for rationing purposes, and, in fact, the Military Dairy Farms department has specifically asked the Nutrition Section for information which these figures provide. At the last Board of Agriculture meeting at Pusa an informal meeting between the officers of the Military Dairy Farms and the Physiological Chemist took place. The latter asked what information the Military Dairy Farms needed most of all and was told that information on maintenance rations was urgently required. Recently, also, in a private communication, Lieutenant-Colonel Matson, Assistant Controller of Military Dairy Farms, said that above everything they wished to know the effective values of rice straw, hay, wheat straw and *jwar*. As the maintenance ration is calculated directly from the net energy value of a foodstuff and the effective value is the net energy value, the Nutrition Section has been able to supply the desired information promptly. The fact is the experiments which provided the information were commenced ten months before the query came, which shows that the Section had selected appropriate work.

The information gleaned from this experiment does not end here. In the course of the work a remarkable physiological effect due to rice straw was discovered. It was found that rice straw produces persistent diuresis, and the cause of this diuresis was traced to the high potash content of the straw. The animal is obliged to get rid of the excessive intake of this base. The figures in the following table taken from a paper recently submitted for publication by the Nutrition Section bring out these facts clearly.

TABLE 4.—*Average excretion of urine and potash by animals fed on rice straw and hay respectively.*

	1000 lbs. animals.		750 lbs. animals.		500 lbs. animals.	
	No. 1 Straw.	No. 2 Hay.	No. 1 Straw.	No. 2 Hay.	No. 1 Straw.	No. 2 Hay.
Average daily urine excretion in kilos—						
1st test. Apl. 1925	7·871	3·947	7·797	3·665	6·299	3·219
2nd test Sep. 1925	6·830	2·842	5·877	3·021	4·968	3·141
3rd test. Nov. 1925	7·572	3·329	7·223	3·338	5·745	2·563
Average	7·424	3·373	6·966	3·341	5·671	2·974
Average daily potash excretion in urine in gms.—						
1st test. Apl. 1925	92·50	33·14	83·77	27·11	61·43	20·14
2nd test. Sep. 1925	100·30	31·50	92·20	26·30	67·13	21·52
3rd test. Nov. 1925	130·58	33·50	119·53	31·27	90·07	22·21
Average	107·79	32·71	98·50	28·23	72·88	21·29

It is impossible to say, at present, what the effect of this diuresis will be. Up to a point the elimination of urine is a healthy symptom. It may be expected to clear the system. On the other hand, the excretion of very large amounts of urine, or of urine of abnormal reaction, is a strain on the kidneys and must inevitably lead to serious results.

That the urinary excretion may be profoundly affected by the nature of the roughage consumed, is, therefore, a discovery of great significance. It is possible that a subject of fundamental importance to animal nutrition in India has been met with here. The question is being followed up tentatively at present. In the first place a circular letter has been sent to the Provinces asking for samples of typical rice straw from all parts of India and Burma. Secondly, pending the arrival and arrangement of this material, the diuretic effect of other roughages has been studied. Ranges of variations in urinary excretion have been observed which exceed the above-noted difference between rice straw and hay. For example, the figures for the average daily excretion produced by two roughages recently examined were found to be 2·50 and 15·55 kilos, respectively.

The systematic examination of Indian roughages is proceeding. A second series of tests, on a somewhat larger scale, with more bullocks and intended to deal with four new roughages has been commenced. The intention in this work is to add steadily to its utility and scientific significance by increasing the number and nature of the observations made during the long period of feeding. Some clinical tests will be introduced this year and eventually it is intended to do respiration experiments with these animals.

(*d*) *Mineral requirements.*—Recent work in Europe has shown that the productive capacity of an otherwise sufficient ration may be completely lost through inadequacy of the mineral supply, and conversely it has been found that the addition of appropriate minerals in such cases greatly enhances the productive capacity of the food. It is impossible to lay too much stress on this question in India. Mineral shortage is common and it must lead to a waste of the potential nutritive power of the organic matter produced by plant growth. Experiments on mineral supplements required for growing stock have been commenced at Bangalore. The test with calves, mentioned above, was used mainly to decide on suitable rations for this purpose. A comparative test was, however, carried out concurrently, a check lot being fed on the same rations, but without a mineral supplement. There was a marked and consistent difference between the controls and the lime-fed lot in favour of lime feeding but stress is not laid on this preliminary result at present. Appropriate rations having been fixed, a more extensive experiment focussed solely on the mineral question has been started. The subject of mineral supplements was, however, deemed of such importance that efforts were made to amplify the work at Bangalore by using outside resources. For this purpose preliminary experiments have been carried through at Hosur (the Central Cattle Breeding Station of the Madras Department of Agriculture) and plans are ready for a trial there during the coming season. A somewhat different experiment relating to the same subject has been proposed to the Military Dairy Farms. The proposal has been accepted and the work will commence as soon as this Section can spare the necessary staff. In the preliminary experiment at Hosur mineral tests were not attempted. A simple feeding experiment to compare hay and grass silage was carried out in order to study the conditions of work there. Thanks to the facilities given to this Section by my friend Mr. R. W. Littlewood, Deputy Director of Agriculture, Livestock, Madras, the effort has been an unqualified success. The results obtained in the first Hosur experiment, though they do not deal directly with the mineral question, deserve notice. Sixteen animals were selected for the experiment. They were carefully paired and divided into two groups. The one group was given hay, the other silage. A weighed excess of roughage was fed to each animal and the residue left by each was weighed

daily. Both groups received the same amount of concentrate, namely, one pound cake and 2 lbs. rice bran per head. The animals themselves were weighed daily during the entire experimental period which lasted 13 weeks. The main results obtained can be shown in a condensed form. The following figures give the changes in live weight which took place during the feeding period.

	Silage group.	Hay group.
Final average live weight per head lbs. .	514	471
Initial average live weight per head lbs. .	485	474
Average increase per head lbs. .	+29	−3

There can be no doubt that the silage was more effective than the hay. To give force to these figures it should be observed that the average live weight per head is taken from the weekly average live weights of 8 animals. Each figure in the table is, therefore, derived from 56 live weight determinations. The first impression from these figures is that silage is far more nutritious than hay. This is not the case. They are probably about equally nutritious. The difference in effect is entirely accounted for by the quantities consumed. The average consumption of dry matter from roughage per head per day was found to be:

for the Silage group	8·363 lbs.
for the Hay group	5·860 lbs.

These are striking and important figures. This experiment has yielded much valuable information. It has shown in the first place that a productive ration cannot be obtained from spear grass hay. The animals consume just enough to maintain themselves. In the second place, it has shown the advantage of converting spear grass into silage. The silage is probably not more nutritious but it is consumed more readily and in amounts above the maintenance requirement. Hence it becomes a productive ration. The hay fed for 13 weeks—together with concentrate be it noted—gave no return whatever. The economics of cattle-rearing are beautifully illustrated by these figures. The experiment has also yielded material from which the nutritive values of the roughages can be determined. The necessary analyses for this purpose however have not been completed yet.

Finally it has to be noted that the rate of live weight increase even with the silage is far from satisfactory. Further experiments are being arranged to investigate this point.

To be fair to the work of this Section the figures for average dry matter consumption per head given above must be referred to once more. They are the figures that have elucidated the real meaning of silage efficiency. These two figures for dry matter consumption are the result of an enormous amount of work. Not only was the ration and residue of each animal determined daily for a period of 13 weeks, but the daily variations in moisture content of the hay and silage had to be allowed for, and in addition to this the partial drying up of the silage while it lay in the trough had to be taken into account daily. To carry out a test of this kind entails labour and demands a great deal of organisation. It is work which can only be done by trained men and a trained staff. In this case, too, it was done at an outstation and not at headquarters. The Section should have more men for dealing with work of this kind.

(*e*) *Indian pasture grasses.*—This work follows along the lines of the most recent observations upon pasture land which have been made in England. Here again the Section has been fortunate in finding outside support. A large amount of work including analyses, digestion experiments and long period feeding tests is in progress at Bangalore on material supplied by the Military Grass Farms. The Bombay Department of Agriculture has taken a

great deal of interest in its pasture problem for many years past. The Nutrition Section, having approached the Bombay Department, is to be provided very shortly with most valuable material from this part of the country. Finally on the strength of the Hosur feeding experiments, already referred to, the Director of Agriculture, Madras, has agreed to the necessity for laying down new grass at Hosur. This is a most important experiment which will eventually provide further material for crucial tests by the Nutrition Section. The work on pasture grasses is particularly important because recent work in England has shown that there is a real prospect of increasing productivity in this direction in India. The work outlined above aims mainly at a determination of the variations in quality which are to be expected. The next step must be an attempt to obtain higher productivity from definite areas which the present experiments are expected to locate for us. This work will involve careful feeding experiments carried out on the spot. The Nutrition Section must have the staff and organisation ready for this approaching task.

(J) Work in the Provinces.—Work in the Provinces is undertaken for the following reasons:—

1. To get in touch with local nutrition problems and conditions.
2. To amplify the work at Bangalore.
3. To test foodstuffs which cannot be conveniently tested here.

Most of the work under this head has been referred to already in connection with the special subjects. An experiment carried out at the Imperial Cattle Breeding Farm, Karnal, which has not been mentioned so far, deserves to be noticed here. The experiment was designed to test the value of different local coarse fodders for winter rationing of calves. The calves were divided into 4 lots receiving, respectively, *dhub* hay, rice straw, sorghum straw and wheat straw, *ad lib.* Concentrate was given in equal amounts to all the animals. Live weights were determined daily and the quantity of roughage consumed by each calf was also determined every day. The results obtained in this long period test covering 120 days are given in a highly condensed form in the following table:—

Ration.	Average live weight per head.	Average weight increase per head.	Average daily roughage consumed.
	Lbs.	Lbs.	Lbs.
Hay	301	·31	5·58
Rice straw	297	·61	6·96
Sorghum straw	300	·57	6·74
Wheat straw	297	·41	5·44

It should be observed that each live weight figure is the average of 42 weighings of 5 animals. Each figure for live weight increase is the average difference between two sets of 21st weighings of 5 animals. The roughage consumption was determined for each animal for 120 days. The figures show that rice straw was most greedily consumed and gave the highest live weight increase. This result is contrary to local opinion which holds that wheat straw is preferable, and the preference is so strong that the local price of wheat straw is four times that of rice straw. A fact of considerable economic significance has been arrived at here. The sorghum may have been somewhat too tough for such young animals and might conceivably show much better results with older stock. The hay result is certainly remarkable. That rice straw should give better results than *dhub* hay, which is believed to be one of the most nutritious grasses in India, is a matter deserving attention. It is noteworthy that these experiments were carried out during the three

coldest months of the year. There is a possibility, therefore, that we have found a fodder which is particularly suitable for the cold season. The point has cropped up by chance, but there is no doubt that if we can recommend special rationing to help the animals through the months of intense cold a very important result will have been achieved. Experiments to test the possibilities in this direction are being prepared. To sum up the results of the first series of tests at Karnal, they have yielded firstly information of economic value which the active Superintendent of that Farm is already making use of; secondly, they have indicated lines for further enquiry one of which has been discussed above.

With regard to all the work in the Provinces one point requires to be noticed. The Section has so organised the plan of procedure to be employed that we are ready to carry out feeding tests in any part of the country. Some time ago the Section carried out a digestion experiment with perfect success at Karnal in the Punjab. More recently a very elaborate feeding test, with 16 calves, a digestion experiment with 8 animals and a nitrogen metabolism experiment with the same 8 animals was carried out without a single hitch by the Section at Hosur in the Madras Presidency.

(*g*) *Training of Post-Graduate students in Animal Nutrition.*—This work was taken up by the Section voluntarily. It is a valuable means for disseminating a knowledge of, and an interest in, animal nutrition throughout the Provinces. The course of training which covers one year includes:—

1. An advanced lecture course on animal nutrition.
2. The planning and carrying out a nutrition experiment under the direction of the Physiological Chemist.
3. The study of all nutrition experiments in progress here.

The work is thoroughly practical. The students have to handle and care for the animals in their charge and have to study their feeding capacity and rationing. Seven students have completed the course up to date.

(*h*) *Assistance given by the Nutrition Section to the Section of the Imperial Dairy Expert.*—1. Courses of lectures on Chemistry (by an Assistant in the Nutrition Section) and on animal nutrition (by the Physiological Chemist personally) were provided for the Dairy Diploma students.

2. The Imperial Dairy Expert asked for a practical procedure for accurate cream neutralisation in connection with pasteurisation. The Nutrition Section carried out an investigation of the question. A practical process was evolved and handed over to the dairy in a workable form.

3. A question relating to cheese-making has recently been submitted to this Section. At present preliminary enquiries are being made.

I would like to record here my deep appreciation of the wholehearted support which my friend Mr. William Smith, Imperial Dairy Expert, has invariably given to this Section, and often it has been given at considerable inconvenience to himself.

6. *Advisory work for Provincial Departments.*—Applications for advice have been received from the Director of Agriculture, Bihar and Orissa, and from the Military Dairy Farms regarding mineral supplements. The required information was supplied. Detailed plans for feeding experiments have been prepared for the Madras and Mysore Departments of Agriculture. The Military Dairy Farms specially asked for information on maintenance rations. One set of results obtained at Bangalore has been provided. Further figures will become available from work which is proceeding now. Questions from the United Provinces relating to the digestibility of certain foodstuffs were replied to. Assistance given to the Imperial Dairy Expert has been mentioned in another place.

7. *Publication.*—The work of publication has just commenced. The results of the first year's experiments (1924) have been embodied in two

Memoirs which are in the press. The completed experiments of 1925-26 will form four Memoirs, but the writing up of this work is only half done. The subjects dealt with are:—

1. Nutrients required for milk production with Indian foodstuffs.
2. Nutrients required for growth production with Indian foodstuffs.
3. Bangalore maintenance experiments, 1st series.
4. Calf feeding experiments at Bangalore in 1925.
5. The relative feeding values of hay and grass silage, Hosur experiments, 1925-26.
6. Roughages for winter feeding of young stock in the Punjab, Karnal experiments, 1925-26.

The following articles have been submitted for publication in the *Agricultural Journal*:—

1. The application of feeding standards to dairy cattle in India.
2. Factors influencing the cost of food for milk production.
3. The relationship between digestibility and net energy values.

8. *Provision for training men for the highest post in the department.*—This Section provides such a training in the Post-Graduate course already referred to, but so far no students have come who could be trained to this extent. Some of the students were altogether unsuitable, owing to inadequate previous education. I will consider only the case of the best men we have had. They were a fine type. They had character and personality, they were gentlemen and my relations with them have been intimate and cordial. It has been a real pleasure to me to have had them here. With regard to their work I can say that they applied themselves to it with zeal and enthusiasm and some of them devoted themselves to it. I must also add that I consider almost all of them fully appreciated and grasped the significance of the work and the possibilities it opened out. They left Bangalore with a sound knowledge of the principles of animal nutrition. But when I am asked whether the men were fit for the highest posts in this subject in the department I have to say definitely—No. Men taking a Post-Graduate course in animal nutrition might be expected to fill a post of:—

1. Animal Nutrition Expert.
2. Cattle Expert or Dairy Expert.
3. Deputy Director of Agriculture.

To become a Nutrition Expert it is essential to have specialised in Chemistry at least. The man who takes up this work must be able to guide the ordinary laboratory processes and deal with the chemical problems which arise. Not one of the men who came here had received the necessary education in Chemistry, not one of them was in a position to discuss procedures with an apprentice in the laboratory. They had received a good general scientific education up to the Intermediate standard, but the final 18 months of study devoted to one or two major subjects had been entirely omitted. My contention is that no amount of post-graduate technical training can make up for this want of scientific training. The point is well illustrated by the case of the man who has not had a chemical training. He may do post-graduate work on animal nutrition for years and yet he will not be qualified to undertake the duties of a Nutrition Specialist. It should be emphasised that the Nutrition Section cannot undertake the additional task of teaching chemistry—for which purpose the Universities exist. It is not for me to say what special qualifications a man should possess to become a Cattle Expert, a Dairy Expert or a Deputy Director of Agriculture, but the modified animal nutrition course which my post-graduate students went through would be of the greatest help to them in any one of these posts. The Nutrition Section feels that this

thoroughly practical course should be recommended and should be taken advantage of because there is a real need to disseminate interest in animal nutrition throughout the country.

9. *Short courses of lectures on special subjects.*—The Section provides a course of lectures on special subjects for the Dairy Diploma students. These lectures, however, constitute a systematic course and not what is usually understood by the term short course. This course of lectures is mentioned elsewhere.

The Physiological Chemist has also given a course of popular lectures on animal nutrition to officers of the Co-operative Departments. The lectures were combined with demonstrations and dealt mainly with the nutrition problems which are being investigated here. The officers who attended these lectures showed great interest in the work and asked many questions.

10. *Co-operation with other departments.*—During the first year of work at Bangalore (1924) the Section was fully engaged in getting its own experiments started. Tentative efforts were, however, initiated for co-operative experiments. Proposals were made to the Madras and Mysore Departments of Agriculture for feeding tests to be carried out at Coimbatore and Rayankere, respectively. Detailed instructions were given. For the former scheme the Nutrition Section merely advocated a trial and gave advice. In the latter scheme the Nutrition Section took a more active part, undertaking all the analyses and the supervision of a digestion experiment. These preliminary efforts were not successful. In one case, feeding instructions were not properly observed, in the other case, the food-supply ran out because the department in question preferred to test a roughage of which the supply was limited rather than the one recommended by the Nutrition Section. The experiments nevertheless served a purpose in showing these departments that such work was likely to be useful. The departments named are contemplating further tests at these stations. During the second year (1925) the Section was in a better position to co-operate with other departments. The initiative in all the co-operative schemes which have been inaugurated during the past year has invariably been taken by the Nutrition Section. The co-operative experiments, which constitute a large fraction of the activities of the Section, have been described already under various heads. It will suffice here to give a list of them.

List of co-operative experiments initiated by the Nutrition Section during 1925-26.

(1) *Madras Department of Agriculture.*—(*a*) Feeding experiments at Hosur. The cattle, the foods and the accommodation are provided by the Madras Department. The work, including a long period quantitative feeding test, a digestion experiment and analysis, are done by the Nutrition Section.

(*b*) Grass experiments at Hosur. The necessity for this work was urged by the Nutrition Section. The first part will be carried out by the Madras Department. The Nutrition Section will institute tests at a later stage.

(2) *Bombay Department of Agriculture.*—(*a*) The Nutrition Section proposed an examination of grazing area herbage. The Bombay Department Committee on pasture problems readily agreed to co-operate in this work.

(*b*) Requests have been made by the Joint Director, Bombay, to the Nutrition Section to carry out certain feeding tests. The Section unfortunately could not undertake the tests this year owing to shortage of staff and very great pressure of other work. It is hoped to meet the wishes of the Bombay Department next year in this matter.

(3) *Military Grass Farms and Military Dairy Farms.*—(*a*) Examination of Indian hay. The work includes analysis of types, digestion trials with types and long period feeding tests with types. The Nutrition Section

carries out all the work at Bangalore. The material is supplied free of charge by the Military Grass Farms. I must acknowledge the zeal with which the Military Grass Farms have taken up the enquiry. Every question is promptly and fully considered; every request is immediately met.

(*b*) Feeding experiment at Jubbulpore. This work has not been commenced owing to shortage of staff.

(4) *Imperial Cattle-breeding Farm, Karnal.*—The experiments designed by the Nutrition Section for Karnal were ably carried out by the Superintendent of the Farm. The digestion experiments and the analytical work were done by the Nutrition Section. The Nutrition Section is very greatly indebted to the Agricultural Adviser, Dr. Clouston, for the financial assistance which he gave for this work.

11. *Obstacles.*—(*a*) The distance of the dairy from residential areas is a very serious drawback to the work. The average distance covered by every man working in the Nutrition Section from the Physiological Chemist down to the humblest menial is 7 miles a day. My men have worked splendidly in spite of this great disadvantage, but the strain is telling on them; there is constant illness and work is falling off. Quarters are required on the spot to remedy the state of affairs.

(*b*) The cross-breeding principles on which milk production at Bangalore is based are an endless trouble to the Nutrition Section. The Dairy only wants half-bred cows. No other stock is of any use. The procedure is that a number of country cows are brought with calf at heel. The cows have been spoilt before they arrive. They will not drop their milk without being suckled. Consequently neither the calf nor its dam is available for experiment. The next lot of calves are half-bred, but the trouble with the mothers persists and the situation remains unchanged. The half-bred cows are excellent in every way. They can be milked without trouble and are available for experimental purposes, but their offspring are useless mongrels which the Dairy sells as soon as possible. Recently I wanted 32 calves for an experiment. Only 8 could be provided out of the large herd. Both Karnal and Hosur have been able to provide as much stock as the Nutrition Section could use. It ought to be made quite clear that there has been no lack of good will on the part of the Dairy, and indeed only good will is to be expected seeing that the Nutrition Section saves the Dairy a certain amount of trouble and expense and generally hands back greatly improved stock. There is no lack of good will but there is a serious lack of material. The remedy is to put the Dairy on an experimental basis, which would enable it to breed and select country stock. To take up this work, I consider, a man with special qualifications would have to be put in charge of the herd.

(*c*) The Nutrition Section should have a few acres of land for growing crops. The need for this has not been absolutely essential up to the present, but it is likely to become more urgent as to the work progresses.

(*d*) Reference has only been made to such obstacles as are interfering with work actually in hand. For further development other obstacles would have to be dealt with.

APPENDIX I.

Statement showing sanctioned staff of the Physiological Chemist, the Imperial Institute of Animal Husbandry and Dairying, Bangalore.

Staff.	1921-22.	1922-23.	1923-24.	1924-25.	1925-26.
1. *Superior staff*—					
Physiological Chemist .	1	1	1	1	1
2. *Subordinate and Gazetted Provincial Officers*—					
First Assistant to the Physiological Chemist.	1	1	1	1	1
Laboratory Assistants .	2	2	3	3	3
Fieldman	1	1	1	1	1
Clerk	...	1	1	1	1
3. *Inferior staff*—					
Laboratory servant . .	1	1	1	1	1
Peons	3	3	3	3	3

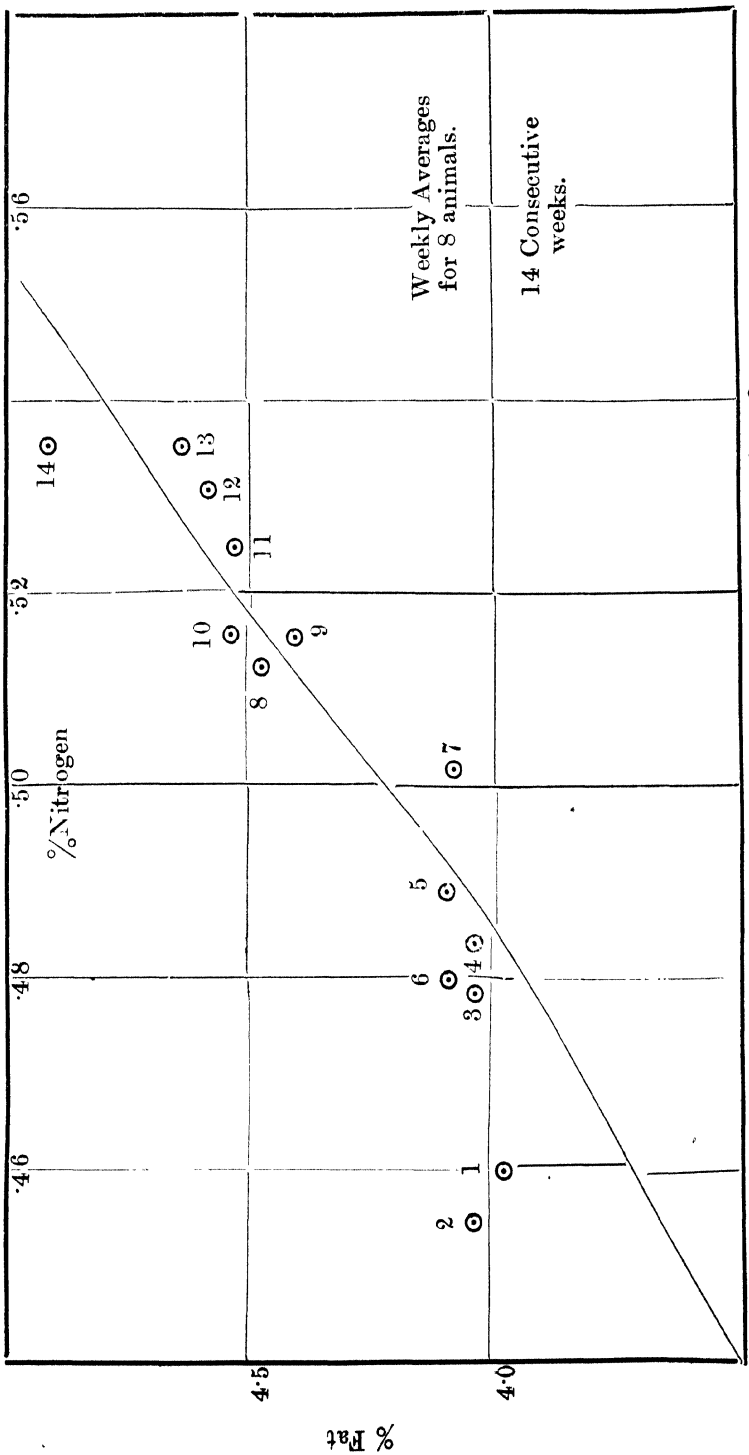
APPENDIX II.

Statement showing the Expenditure and Receipts of the Physiological Chemist, the Imperial Institute of Animal Husbandry and Dairying, Bangalore.

	Rs.	A.	P.
Expenditure—			
1921-22	**21,114**	**0**	**0**
1922-23	38,479	0	0
1923-24	52,499	3	6
1924-25	51,838	4	11
1925-26	46,069	13	7
Receipts	*Nil.*		

APPENDIX III (*a*).

The Comparison between Bangalore Milk Analyses and American Average figures.



The continuous line represents American figures.

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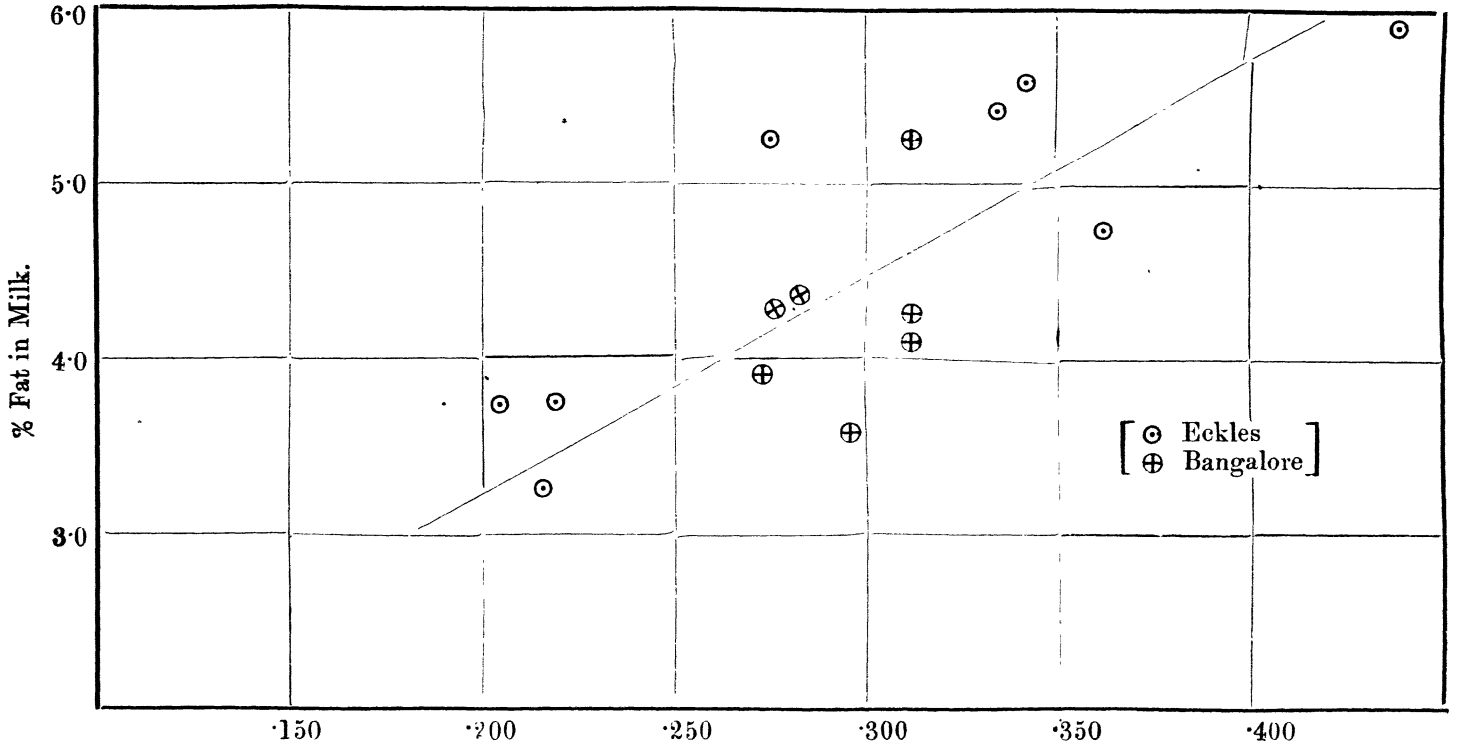
APPENDIX III (*b*).



Replies to the Questionnaire.

QUESTIONS 1 (*a*) AND 4 (*a*).—CO-ORDINATION OF RESEARCH AND ADMINISTRATION.—Considerable changes have taken place in the work of the Agricultural Departments in India during the last few years. The amount of work being done has increased rapidly. The scope of the work has become very much wider. All the Provinces are rapidly providing themselves with facilities in every branch of science which is needed for furthering agricultural research. While the work is increasing the contact between the different Provinces is decreasing. Co-ordination has made no progress. I believe that very great advantages may be obtained by co-ordination and I am in entire agreement with the scheme outlined by Dr. Clouston for bringing about co-ordinated effort. In favour of co-ordination we have the following facts:—

1. However perfect the facilities provided may be, every Province will have features of its own and will be able to help other Provinces in some lines.

2. It is not economical for every Province to work for itself only. There are many enquiries which can be carried out in one place and will yield information applicable to the whole country. For example, the effect of a common foodstuff upon milk production need not be tested independently all over the country. Carefully planned tests carried out at one dairy will yield information for all the dairies.

3. There are questions which cannot be adequately dealt with in one institution. The data required may be so numerous that several institutions must combine together to procure the required information. Some important questions on milk production which will be described later, would come under this category.

4. There are some questions which can be dealt with most economically and conveniently by a Central Institute. The net energy values (Starch Equivalents) of foodstuffs, for example, must be studied at a Central Institute, and the work done there must be arranged by consultation so that the requirements of the different Provinces and tracts are given due weight.

5. Comparative studies of foodstuffs such as the Nutrition Section of the Imperial Department of Agriculture has instituted required co-operation between the Imperial and Provincial Departments of Agriculture. Such comparative work is of the highest importance not only for gauging the potentialities and deficiencies of foodstuffs, but also for determining the capabilities of different breeds of cattle. The Nutrition Section has already noted remarkable differences between Indian and cross-bred cattle in the course of such work. Co-operation with the Provinces is sure to yield more information. This is a class of work in which a Central Institute is essential.

In all these cases we require joint consideration of the problems and a systematic distribution of effort. Other branches of agricultural research should undoubtedly be dealt with in the same way.

Dr. Clouston's scheme for effecting co-ordination.—I would like to make some remarks on Dr. Clouston's proposals.

1. The Advisory Council for Agriculture in India. This Council would function more or less on the lines of the Council in England. It would not be concerned directly with the activities of the Provincial Departments of Agriculture but it would be kept in close touch with the work through provincial representation on the Council and would arrange for the execution of co-ordinated work with the Provinces. The primary duty of the Council would be to keep in touch with the progress of agricultural research through Committees of Experts. The members of the Committees would not be drawn from the Council but each Committee would be adequately represented on the Council. The second function of the Council would be to consider and endorse the recommendations of its committee and to take the necessary steps for having the work carried out. To effect this the Council must be strong and representative. It must also possess ample funds and must be able to call upon the staff of the Imperial Department for assistance.

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2. *Institutions under the Government of India.*—Well-staffed and well-equipped specialised institutions under the Central Government are required for carrying out co-ordinated enquiries in co-operation with the Provinces (the functions of the Nutrition Section in this connection have been exemplified above). These institutions may also be called upon to provide experts and expert assistance to the Provinces engaged in co-ordinated work. The present institutions under the Government of India will require considerable expansion to meet these demands. Instead of a Dairy Section and a Nutrition Section larger separate institutions for these subjects are required.

3. *The Committees* nominated by the Council will form the backbone of co-ordinating enterprise. Success in the scheme will depend entirely upon the work done by the committees. They must be given every encouragement and support. I strongly urge the formation of a committee to deal with animal nutrition. The nutrition problems of India are too serious and too diverse to be dealt with as a side issue.

QUESTION 1 (*b*).—Progress in Research on Animal Nutrition is seriously hindered in a number of ways:—

Firstly, there is a lack of facilities in the field. In the study of mineral shortage (to take one example only) it is absolutely essential for the Nutrition Section to carry out feeding tests in selected localities. Such tests could be conducted very easily on farms belonging to the Provinces. The Nutrition Section has carried out one test of this kind at a cost of Rs. 300, the funds being obtained from a special grant. The experiment was carried through without a single hitch and now the Section has received two cordial invitations from Provinces for further experiments of this kind. Unfortunately we cannot undertake this work because it involves the expenditure of money from Central revenues at a provincial farm and the temporary transfer of one or two subordinates from headquarters to a provincial farm. As matters stand at present this constitutes an improper diversion of Central revenues, though actually it is a very economical arrangement. Instead of opening up independent cattle farms the Nutrition Section could co-operate with the Provinces, using their cattle and their foodstuffs free of charge, for the elucidation of nutrition problems which are of vital interest to the whole country. Considering the tremendous economies which this proposal offers, the unnecessary duplication of farms which it avoids and the possibilities it opens up for real progress in Nutrition questions I feel confident that the Government of India will be prepared to sanction work on these lines at once, if it is approved by the Royal Commission. Animal Nutrition in India cannot be studied adequately if the work is confined to a laboratory at headquarters.

In addition to field work in the Provinces some field work is essential at headquarters. The Dairy at Bangalore as at present constituted has no land whatever to spare. In fact there is no room here for two Sections. Either it must be a Dairy Institute or it must be a Nutrition Institute. The space is even cramped for a Dairy Institute alone. The fact that the Dairy purchases a large proportion of its roughage from outside is a sufficiently striking proof of this statement. The place is not ideal for a Nutrition Institute especially as it is under an obligation to provide milk for the troops, but the milk production could be reduced down to the Military requirements and thus the available space of nutrition work would be considerably increased.

Further, important nutrition work on milk production must be undertaken in this country. Much of this work will have to be done in collaboration with other dairies but some of it must be done in a dairy attached to and in the control of the Nutrition Section. The Nutrition Section requires a dairy and the Bangalore dairy suitably modified would meet the requirements. I must make it quite clear here that it is not my wish to obtain this place for the Nutrition Section if the Dairy Section finds it suitable and wishes to retain it. The point is that there is not room for the two Sections here. We are blocking one another on the ground. In other respects too the close juxtaposition is not healthy. The Dairy Section gives a dairy diploma course and relies upon the Nutrition Section for lectures on elementary science,

nutrition and dairy chemistry. Needless to say the Nutrition Section gives what it can gladly. We are pleased and we will always be pleased to be able to do anything we can in return for the whole-hearted help we have invariably received from the Dairy Expert. But the fact nevertheless remains that the Dairy Section is incompletely staffed and has to fall back on this Section. The conditions do not make for healthy development.

Another great difficulty to which I have referred in my memorandum is due to the fact that the dairy is run as a commercial concern and is therefore obliged to go in for cross-breeding. The result of this cross-breeding is that there are very few calves available for experimental purposes. The Nutrition Section was transferred to Bangalore because it was believed that we would have an ample supply of animals here. In the case of calves this is not so. There is an ample supply of cows and the Section will very soon be able to commence new work on milk production, but it is not likely that we can do a great deal even on milk production until we have a dairy under our complete control. In this connection it may be recollected that the School of Animal Nutrition at Cambridge recently decided to establish a dairy of its own for carrying out investigations in milk production.

The situation of the Bangalore dairy so far from residential quarters is another great drawback to the work on Animal Nutrition. For efficient work quarters are required here for the entire staff.

In conclusion, I consider that the site would probably be suitable for either of the Sections, but it is not suitable for both together. If it is intended to establish efficient and well equipped Sections for Dairying and Animal Nutrition more space is absolutely essential to allow for the necessary expansion. I would like to suggest the Belgaum dairy as a suitable place. The Military authorities might be prepared to hand it over on terms similar to those under which the Bangalore dairy was transferred.

QUESTION 16.—FODDER AND ITS STORAGE.—*Sorghum* is the most important fodder in India. Broadly speaking there are three types:—

1. Grain *Sorghum* used only for human food. The stems are very thick and cannot be fed to cattle. They are frequently used as fuel.
2. Grain and fodder *Sorghum*. The grain is used as human food. The stover (dry stalks and leaves) is chopped and fed to cattle.
3. Fodder *Sorghum*. This type is grown only for cattle food and is fed green.

We have carried out a few tests with a stover (chopped stalks and leaves) of the second type. Considering the nature of the fodder it is eaten with fair relish and the digestibility is as good as or better than rice straw. For older animals which can eat it in sufficient bulk it is superior to rice straw. The dry fodder is easily preserved in stacks. Tests, carried out by the Nutrition Section, with green *Sorghum* have shown that it is a rich, nutritious and easily digested food. An experiment at Bangalore with very carefully cured *Sorghum* hay, probably the best that has ever been made in India, was not very encouraging. The digestibility was not high It would appear therefore that hay-making from *Sorghum* is not likely to help agriculture. *Sorghum* silage on the other hand is remarkably good. It has been repeatedly tested at Bangalore and has given excellent results. Silaging fodder *Sorghum* for storage can therefore be recommended strongly. Hay-making does not seem to be satisfactory. However very much more information is required concerning the merits of *Sorghum* stover and hay.

Hay.—At Bangalore we have tested numerous samples of hay from different parts of the country baled, stacked and fresh samples have been examined. Generally the quality has been poor, many samples being less nutritious than rice straw. The causes of this bad quality have not been worked out yet. In some cases it would appear that the soil and climate were at fault. The green plant itself was poor material, containing a very high percentage of silica. The proportion of silica however is not always an index of quality. Rice straw is rich in silica but is moderately digestible nevertheless. In some

cases the bad quality was undoubtedly due to late harvesting. Experiments on the question of harvesting are very urgently needed. It is quite possible that in some localities the grass is over-ripe at the time of the rains. It is useless to attempt hay-making in such regions. A better use of the food would be to convert it into silage for local consumption. It is important to find out whether there are areas where good hay can be made.

Preservation of green fodders.—I believe that silage making as an art unknown to indigenous agriculture, can be introduced almost everywhere for preservation of grass and monsoon fodders. Fodder preserved in this form is very easily digested whilst drying fodders in this country seems to lead to reduced digestibility in some cases. I believe Indian agriculture will benefit very materially by the extensive use of silage.

NUTRITION IN RELATION TO BREEDING AND MILK PRODUCTION.—1. More stress should be laid on the fact that provision of good bulls is not sufficient to improve the cattle. Deterioration must be attributed partly to bad feeding. The food-supply should be studied in areas where bulls are introduced.

2. There are some difficulties connected with the feeding of good dairy cattle in India. The ordinary milk mixtures which have been found satisfactory in Europe are too expensive to be used here. It is important to carry out tests with a variety of our economical mixtures over very long periods to determine what effect they have on the cow's life and vitality. Will her useful life be affected materially by such differences in feeding? This question is of very great economical significance. It can only be studied by well organised co-operative tests. The question of mineral supplements for cows is another matter on which the milk yield, the cow's useful life and the vigour of her offspring depend. There are many vague beliefs regarding stimulating foods and foods which tend to hasten drying. Dairymen require assurance on these points. For the dairy industry therefore special nutrition enquiries are needed. In this work the guidance and co-operation of a strong Nutrition Institute are indispensable.

3. *Breeding and milk production in cultivated areas.*—I believe silage would greatly benefit breeding and milk production in cultivated areas. Under normal Indian conditions it is the young calf that suffers most of all. It is put on to hard dry roughage long before it has developed a capacity for such food. In Bangalore the Nutrition Section has observed the fatal effects of feeding average quality Indian hay to calves. They cannot learn to fill themselves and the Net Energy Value of the food consumed is barely sufficient for maintenance. It is useless to add a rich oil-cake to such a ration. On the other hand silage feeding to young calves has given us remarkably good results. It has never failed. Legume hay is also worth considering. I made hay from Phaseolus Mungo in Burma. It was a rich food and was very much relished by cows and young stock. I believe that some legumes containing prussic acid could be converted into perfectly safe and nutritious hay. For example, Phaseolus Lenatus plants contain a very large amount of prussic acid but on drying in sunshine the poison is completely eliminated. Such legume hays would form excellent food for growing cattle.

PASTURE PROBLEMS.—The pasture problem in India is intensely complicated and our knowledge of the different aspects is meagre.

1. *Quality of pasture grasses.*—We distinguish good grasses from poor ones partly by the conditions under which they thrive, that is to say, we assume that the good grasses are those which grow on good ground, but we have no direct evidence that the so-called poorer grasses are not equally nutritious when they occur on good ground. The Nutrition Section working in collaboration with the Bombay Department of Agriculture is attempting to clear up some of these preliminary difficulties. We may also distinguish poor and good grasses from the way they are relished by cattle. Here again it is not likely that the nutritive value is the only factor influencing relish. Taste, smell and presence or absence of hard awns play a part. That cattle are greatly influenced by taste was demonstrated a short time ago in one of our

Bangalore experiments, in which some of the animals refused to touch a very nutritious soft hay which is eaten with relish by animals brought up on it. The same thing doubtless occurs on pasture land. The animals are eating one kind of grass and it is practically impossible for them to change over to another kind of perfectly good grass even if they are nearly starving. It is by no means impossible that at some future date the question of taste and smell will have to be studied chemically to elucidate our feeding difficulties. The awned grasses such as *Andropogon contortus* are definitely a great nuisance in our pastures and must be classed as bad though the cattle do eat them sometimes. The Nutrition Section is engaged at present in determining the intrinsic values of different pure species and in estimating the effect of environment on these values. The mineral question is receiving attention at the same time. As this work has only just commenced there are no data available.

2. *Improvement of grazing areas.*—Grazing is a process of selection in which the animal consumes the good grasses and leaves the poor grasses. It might be supposed therefore that light grazing would tend to eliminate the good species and favour the poor ones. Carrying the same argument further, close grazing should be less harmful because it would cause a reduction of the poor grasses also and hence less change of herbage should result. Another method of avoiding selective consumption is to mow the grass. In this way all species have an equal chance and the pasture should accordingly improve. These expectations are entirely contradicted by practical experience, which shows that close grazing is generally fatal to pasture land in India, whilst mowing does not bring about any improvement in species. The herbage depends mainly upon the quality of the soil and upon its moisture content. Close grazing reduces the organic matter in the soil (the root system is reduced to begin with) and also the water holding capacity of the soil and the soil moisture, whilst erosion is favoured. The soil becomes poor, the yield of herbage falls and its quality declines. Dr. Burns in Bombay has shown that fencing and protection from overgrazing improve the soil and the herbage. Bunding and regulation of the flow of water may be expected to produce good results also. Cultivation, which has recently yielded such good results in Great Britain, might be tried with advantage, but in making such attempts in India certain precaution would have to be observed. The first effect of cultivation is very often a great stimulation of weeds and a set-back for the grass. Light disc harrowing is most likely to help the grass. I have no practical experience in this matter however. Much better cattle food may be expected from areas of mixed farming, but the close grazed areas are too poor to be cultivated. There are innumerable instances in this country of crop production on the fringe of culturable land. The grass is ploughed up and a meagre crop of *juar* is obtained. Following that we have a useless plot of weeds for a couple of years after which the grass slowly establishes itself again. It seems to me that amelioration of the land might be tried in such areas, by fencing, encouraging grass growth in accordance with Dr. Burns' procedure and control of surface water.

3. *Mineral deficiencies in fodders.*—The Nutrition Section is collecting material from various sources for the study of this important question. The bulk of the work at present consists of chemical analyses of typical samples. One very remarkable result has been obtained in a feeding experiment. A sample of Indian hay supplemented with concentrate gave a negative digestion of minerals. When it is recollected that only a part of the digested mineral matter is retained in the body it becomes clear that we are here in touch with a most serious case of mineral shortage. It is probable that the question of mineral deficiencies is one of the most important nutrition subjects in India.

Oral Evidence.

A.414. *The Chairman :* Mr. Warth, you are Physiological Chemist in charge of the Animal Nutrition Section in Bangalore?—Yes.

A.415. You have put in a very interesting note for which we are greatly obliged. I have very few questions to ask you. Your note is concerned mainly with technical points. I have no doubt that we shall learn a good deal from our visit to your Institute this afternoon?—I hope to show it to you this afternoon.

A.416. I see that in the early part of your note you point out that there is difficulty at the moment in your making the fullest use of your opportunities for collaboration with the provincial authorities owing to the decision of the Government of India that Central revenues ought not to be spent on provincial institutions?—I would not like to put it quite so definitely as that. I do not know that there has actually been a decision on that point; it has been pointed out to me by the Agricultural Adviser that this would probably not conform with the conditions at present prevailing.

A.417. Has any expenditure suggested by you ever been turned down on that ground?—I wish to do an experiment immediately, and it is being held up on that account.

A.418. So that it would seem in that case that a definite ruling of the kind I have mentioned has been given?—Yes.

A.419. Do you find the Provinces anxious to make use of the help which you are giving them?—I have been cordially invited in two places.

A.420. And you think, to get the best value out of the money expended, that the Government of India would be well advised to allow the Central revenues, under proper safeguards, to be spent in the manner you suggest?—I do, because I consider the work cannot be done unless it is done in those particular places which we select.

A.421. On page 66 an interesting point is raised. You are talking about the difficulty of carrying on research work in a dairy run as a commercial concern. Is it your view that herds or dairies run for the purpose of research are not to be expected to pay their way?—If they are doing research work they cannot pay their way.

A.422. When you come to demonstration, that is a different matter altogether, is it not?—If you are to demonstrate the profitableness of a procedure it must be profitable.

A.423. And it is very important not to attempt to demonstrate on the profit-earning potentialities of an industry at an institute where money is spent on research unless you have your experiments entirely separated?—It would be very difficult to separate them; it might possibly be done.

A.424. Have you had personal experience of propaganda?—I have had no experience of that kind at all.

A.425. I judge from your paper that although you have done a great deal of work already you yourself feel that you are only at the beginning of your labours?—We have only commenced; we have just begun to touch the problem.

A.426. And yet the results which you set down here appear to a layman like myself to indicate great possibilities for the future?—The conditions are so absolutely different in India that we are bound to point out important facts.

A.427. You are really doing entirely original work?—Because the conditions are so different, the work is quite original.

A.428. You are doing some important work in the matter of the nutritional value of various fodders?—Yes.

A.429. How do you envisage that information being placed at the disposal of the cultivator in his village when it is ready for publication?—I envisage

all this information as going to the cultivator through the experts who are dealing with cattle, not from me to the cultivator.

A.430 It will be a question of recommending particular fodders?—To the institutions where work on cattle-breeding, cattle-feeding and dairying are proceeding.

A.431. We are accustomed in Great Britain to be advised by experts like yourself as to the proper balanced rations. That is hardly a practical proposition in this country, is it?—With regard to the feeding of cows it is an important matter, especially when they are high milkers; that will be a difficult matter in this country as I have pointed out in my answers.

A.432. But you do think that your work will lead to interesting results in the matter of choice of foodstuffs for cattle. Do you think it likely that your results will suggest that particular cattle are more suitable to particular districts owing to their capacity to digest and make the best use of food produced in those districts?—I cannot say; it is possible.

A.433. You are very emphatic as to the value of silage and as to the practicability of successful propaganda in the direction of spreading the practice of making silage?—Because our results have been so very satisfactory with it; they have been altogether satisfactory; it is easy and cheap and good and sure. It cannot be burnt of course.

A.434. Is it spreading at all to your knowledge?—I believe all the Provincial Governments are doing their best to push it forward.

A.435. Of course to the uninitiated mind it looks so improbable as a process until you see it done that it is difficult for them to believe that it is practical?—Yes, it is so.

A.436. I take it the only hope of persuading the cultivator to adopt it is to give him a demonstration under the conditions with which he is familiar? —Yes, and the demonstration is so easy.

A.437. On page 64, you give the Commission your views as to the merits of Dr. Clouston's proposals for the co-ordination of research work in general in India. Have you any ideas of your own other than those which you have set down in your note of evidence as to the constitution of a central body which might be set up?—I have not gone into the details at all. My object in writing this was to give an example of how extremely useful such a scheme would be as applied to the work of animal nutrition and suggesting that in all probability it would be equally useful in other directions.

A.438. I see that like Mr. Smith you are of opinion that sooner or later a separate herd at a separate institution will be required for your work alone, apart from the dairying and cattle-improvement work?—The point is that the place we have will not contain us both; we are at the limit; we are in fact stepping on each other as it is.

A.439. Would you rather go to a distance with an entirely new institution or would you rather have an extension here?—I am afraid the question of extension here would be found to be impossible. There is simply no land available, and therefore it cannot be considered. I am afraid that is the case.

A.440. It does seem at first sight that contiguity as between the work being carried on by Mr. Smith and the work immediately under yourself would be an advantage in the matter of teaching?—It is a most unfortunate thing; I regret it; but the place will not admit of it.

A.441. You and your staff are doing a certain amount of teaching?—We are doing what we can; I do not think that the teaching that we are doing for Mr. Smith's section is of such a high standard that it could not be done very easily by his own people if he had more staff. That I consider a trifling matter. There are other matters where contiguity would be useful in combined efforts; that is mainly what we would be losing.

A.442. Do you not think that in the future the teaching side of your work will necessarily increase?—I consider that the main increase I may expect is in the matter of post-graduate students, not in direct teaching of junior students.

A.443. So I should expect; so that having that in mind, you see no reason why post-graduate training in your work should not be carried on at a separate institute?—Quite easily.

A.444. Are there any signs that greater interest is being taken in teaching animal physiology?—I cannot say.

A.445. Are you having any applications at all from graduates?—We train about a man or two a year, mainly men who are going in for dairying. We have at present a man under training, a qualified man in other ways, who is going to take up the work of animal nutrition in the Madras Presidency.

A.446. Are there other openings in India for the type of physiological chemist whom you would train as a post-graduate learner?—At present, none. I think the work of animal nutrition must increase throughout the country, and if that were so, we would probably have the duty of training men for the posts.

A.447. Do you think that the teaching side has an important reaction on the research side in the case of your own work?—It is no drawback whatever; it is probably a help and an inspiration.

A.448. I do not know whether there are any other observations of a general nature that you would care to make before I ask my colleagues to put questions to you?—I have nothing to say.

A.449. *Sir Ganga Ram:* Have you published any pamphlet naming the different fodders on which you have made experiments, and the results?—We are slowly publishing the work that we are producing, but we have not got very far with the work of publication at present.

A.450. I only want to know the names of the different fodders on which you have made experiments?—We have recently done a large number of experiments on samples of hay produced in this country.

A.451. What do you mean by hay?—I mean grass duly cured to make it into hay.

A.452. Not wheat straw?—No. We are about to test wheat straw; we are about to carry on a long experiment on wheat straw.

A.453. And gram straw?—We have not done that.

A.454. Have you made any experiments on *senji*?—No.

A.455. Do you know what *senji* is?—I do not.

A.456. Mr. Smith probably knows about it. In the Punjab it is largely given to milch cattle; we call it *senji*?—We would like to test it. There is a tremendous task before us of testing innumerable foodstuffs; we know nothing about them at present.

A.457. What is the meaning of "roughage"?—All foodstuffs which are bulky and not highly nutritious.

A.458. It is not a mixture of straw and cake and that sort of thing, is it?—Well, the cake is a concentrate, but straw is the roughage.

A.459. You say there is a mineral shortage. Do you mean salt? Or what?—Recent work in England has shown that many foodstuffs are short of lime, phosphoric acid, and minerals of that kind. We believe there are severe shortages of these essential minerals in various parts of the country.

A.460. Lime, phosphoric acid and what else?—I am afraid I said "and various other minerals." It may be sodium and chlorine.

A.461. And salt?—Yes, and salt.

A.462. *Sir Thomas Middleton:* You have just told us that your main work at present is investigating the quality of food materials?—Yes.

A.463. You have got, I assume, a pretty good knowledge of the composition of the grain of India?—I had to select what work seemed most essential and it appeared that we know more about the grain crops than about the coarse foods, so that I have specialised in coarse foods.

A.464. There have been a large number of analyses of the main food grains of India, but the coarse fodders have never been investigated?—That is so.

A.465. How are you dealing with the problem of the quality of the coarse fodders? First of all is there a chemical analysis?—We carry out chemical analysis in these, combined with digestion experiments and long or short period feeding tests, in fact as big a test as we can with the material available.

A.466. You do carry out digestion experiments here?—Yes; we do not consider we have carried out anything at all unless we have carried out digestion experiments.

A.467. Supposing you take one material such as *Sorghum* fodder grown and harvested under various conditions in India, do you find very wide difference in the digestibility of the samples of *Sorghum*?—That is an important piece of work which remains to be done; we know nothing about that.

A.468. You are at present concerned with the types and not the variations?—Yes.

A.469. Could you give an indication of how many types of grasses you have had under investigation? You have investigated mixed herbage, but I suppose you have also been dealing with individual species?—For feeding tests we have not carried out a single test for absolutely pure herbage yet except perhaps *dhub* grass. That was probably almost pure. We have also tested Rhodes grass.

A.470. Have you tested guinea grass?—Guinea grass we have not actually tested, though it is on the farm. The other fodders were mixed herbage as found in various areas.

A.471. *Sir Ganga Ram:* Have you published any pamphlets on these two grasses?—I have not.

A.472. Where can we get them?—We are not quite ready to publish these things yet; we are collecting the information.

A.473. *Sir Thomas Middleton:* So that you are not able to verify the Indian cultivator's opinion of his several species; you judge from an examination of the mixed species in hay, and can only form a rough idea of the relative quality of the grass contained in the hay?—That is so. But the work is only beginning; that is really the point. I cannot speak with certainty about any of those matters.

A.474. Now, coming from the food materials to the needs of the animal, are you doing any independent work to ascertain the needs of the Indian animal as distinguished from the needs of those that have been worked out in other countries; *e.g.*, do you adopt the usual standards provided for the milch cow in Europe and America as a basis for the standards in use in Bangalore or have you investigated the needs of the Indian cow independently?—We have studied the effect of feeding cows in India with the standards adopted in America; we have to use American standards because they apply more to our foodstuffs than the European standards. We have found the cows very economical in the use of this particular standard. I cannot say more than that at present.

A.475. *Professor Gangulee:* The Armsby standard?—The Armsby and the Henry and Morris, or both.

A.476. *Sir Thomas Middleton:* You have been using American standards. Are you using the bomb calorimeter in your work?—We have done no calorimetric work. I admit it is an urgency; but we have got to build up these things.

A.477. Whereas the standards required for milk production have been pretty fully worked out in other countries, we are still very ignorant of the animal's needs for work production; especially as such standards as exist have been worked out for the horse. Has any attention been given in India to the needs of the working bullock as distinguished from the milking cow?—Actually

some work has been done; but we have not got good figures at present. I see no way of attempting that problem immediately.

A.478. It is a very difficult problem?—But we have considered it, and we have got plans partly prepared for doing work.

A.479. Would you say in the case of working animal as in the case of the milking animal, that the Indian animal is economical in its needs?—I have found the Indian bullock extremely efficient in digestion; I can say nothing more than that.

A.480. The Government of India supplied a memorandum to the Civil Research Committee last year on the question of mineral deficiency in pasture. Did you take part in the preparation of that memorandum?—No; I had no information to give. But we have since then made a little progress, but there is very little progress to record.

A.481. That explains your answer to Sir Ganga Ram?—Yes.

A.482. Could you be more specific; could you indicate to me any districts in which there are indications of mineral deficiency?—I suspect one district, but I would rather not say anything definite at present.

A.483. Have any cases of iodine deficiency come to your notice?—No.

A.484. You make a suggestion in your memorandum about the possibility of adopting a method that has given good results in Great Britain recently in improving our poor grass land. Are you referring to Professor Stapledon's writings?—Well, actually when I wrote that I was thinking of some of the work they have done in Wales.

A.485. That is Professor Stapledon's work?—Yes.

A.486. You must recognise that Wales has a climate which is peculiarly suitable for this method of improving pasture land. I personally should doubt very much whether it would be likely to succeed under Indian conditions?—I am not prepared to say anything on the subject except as a suggestion.

A.487. *Dr. Hyder :* There is some post-graduate teaching done here under your direction?—I have had students during the last three years.

A.488. And you are not satisfied with the standard of knowledge of chemistry with which these people are equipped?—It depends on what work they are to do when they leave me; if they are to be cattle-breeders or cattle experts, I consider that I have shown them something about the value of foodstuffs which will be useful to them; if they are supposed to go back to their Province and take up the study of animal nutrition, I say they cannot do it.

A.489. Let me go into the question of the relation of Indian Universities to the instruction given by you. You know that we have the B.Sc. and the M.Sc. In the B.Sc. you must have either chemistry or physics and one more subject. In the M.Sc. you need have only one subject, chemistry for example In the Honours course there is a thorough grounding in chemistry, and one or two subsidiary subjects, *i.e.,* to test the knowledge of the student in English and in another subject like that. I cannot make discrimination between the Universities, but take the M.Sc. or the Honours standard. Do you think a man who takes an Indian M.Sc. degree in chemistry would be able to carry on such researches as you are carrying on after he has passed through a course of training given by you?—I see absolutely no reason why he should not; there is no reason at all. I should say that he has undergone a training which will fit him for the work. It depends upon the man entirely; I think he would be perfectly able to do it; there is no reason why he should not be able to do it under those conditions.

A.490. For the proper development of post-graduate teaching here so that these people might become dairy experts or might carry on research such as you are carrying on, would you insist upon either an Honours degree in chemistry or an M.Sc. degree?—It depends upon his future work. If he is to do this class of work then he must have a high training in chemistry or the allied work that he proposed to take up; if he is going to be more on the agricultural side, that is not necessary.

A.491. That, of course, would be a waste, if he went to the agricultural side and gave up the special training which he has received?—If he is going to be a cattle expert, he really ought to be a cattle expert even when he comes to me; an Honours degree in chemistry is not required for that part of the work; but if he is going to take up the study of nutrition, then he must possess chemical knowledge.

A.492. Our object is to aim at the production of bio-chemists attached to different institutes in different Provinces of India. I personally consider that it would be a waste of your time and resources if these people went over and became cattle experts?—I should say that they would have had one kind of education and were going to try to do something else.

A.493. There are no other bio-chemists attached either to the Indian Universities or attached to departments of Provincial Governments?—There is nutrition work being carried out; very useful nutrition work is being carried out at Lyallpur by the Agricultural Chemist there.

A.494. *Sir James MacKenna* · What do you consider to be the most important All-India problem in animal nutrition which is facing us at present?—I think the mineral deficiency in our foodstuffs is the most important All-India problem.

A.495. Have you taken it up yet?—We tried to take it up.

A.496. What are the difficulties in getting on with that?—It is again this question that we have just had before us; I cannot do the test at the place where it is essential that the test should be done.

A.497. That brings you up against the Devolution Rules?—Yes, the Devolution Rules are hindering this work which, I must say, is the most important question.

A.498. Until you have free access to the Provinces and the right to spend money in the Provinces, you cannot get on with this very important All-India question?—No, I cannot.

A.499. You are doing a certain amount of work on fodder crops?—Yes.

A.500. Have you any facilities here for testing fodder crops?—There is no room at the dairy, as I have already pointed out, and it is absolutely essential that I should grow crops for testing. I cannot grow any crops for testing.

A.501. Can you give us any rough idea of the equipment and the staff necessary to make your section self-contained and adequate to tackle the problems you have in front of you?—Well, just to deal with this one single point I consider I require 100 acres of land for fodder crops.

A.502. What staff do you require?—The farm staff to deal with that.

A.503. That is a matter of detail?—Yes, I have not considered it.

A.504. That is a matter for you to fight out with the Government of India?—Yes.

A.505. *Professor Gangulee :* For the investigation of mineral deficiency, you could not get adequate laboratory facilities?—Our laboratory is very small, as you will see this afternoon. We can do a fair amount of work in it; we are not really afraid of that; but the chemical analysis of foodstuffs does not give the necessary information. You must test it on the animal and you must test it on the animal at the place where it is produced. That is our trouble.

A.506. And for that you have not got sufficient funds?—It is not so much the funds; it is the procedure which is illegitimate almost, you may say, for us to follow at present. We have not the right to work at the places where we want to carry out this work.

A.507. Your expenses are another question; the question is that you have not the proper facilities for carrying on the work?—Expense is a small thing, but of course it is a factor which prevents us from working; we are not allowed to expend the money for that object in the Province.

A.508. You say in your memorandum that you took up this duty of training these post-graduate students voluntarily; was that without any direction from the Central Government?—If you wish me to lay stress on that, I more or less insisted on doing it, when it was perhaps objected to.

A.509. You felt the necessity of having post-graduate students?—I wished to have them.

A.510. And without any direction from the Central Government?—Not in the first place, no; I asked for it, and then I was allowed.

A.511. About 7 students have already completed the course?—Yes, about 7.

A.512. Could you tell us how they are being employed now?—One of the students is Assistant Professor of Agriculture in the Punjab; two, I believe, are Deputy Directors in the Punjab; one is the Manager of the dairy at Nagpur.

A.513. It is rather gratifying to see that you hold a very high opinion of those who actually took the course?—They were selected men who were sent to me, and I found them very nice and agreeable men.

A. 514. And yet you say definitely that these men were not fit for higher posts?—I said they were not trained for taking up the work of animal nutrition. I think I gave you that reply.

A.515. *Dr. Hyder:* May I make that clear? If you had a first class or second class M.Sc. of an Indian University and he received training under you, would you say that such a man was fit or not fit for a first class post?—I say that there is no reason whatever to suppose that he would not be fit.

A.516. *Professor Gangulee:* What are the qualifications of these men that you have trained?—I specified them in my memorandum. I cannot say exactly now what it was. They had not specialised in the important and necessary subject.

A.517. Referring to your own research, you have made a very good beginning in the investigation of some of these fundamental problems of animal nutrition. Have your investigations attracted the attention of the Provincial Departments of Agriculture?—I do not think the Provincial Departments of Agriculture are really at present aware of what work has been done. We have not been able to publish very much so far.

A.518. You say, I think, in your printed memorandum that the Military dairy farms took up the question, and they came to you for advice and direction, and also that you started co-operative experiments in the Provinces of Madras, Bombay and so on?—That is so.

A.519. They were attracted by your work?—Perhaps we went to them; they did not come to us. We cannot say that the work has made any great impression on the country, because it has just commenced.

A.520. You do a considerable amount of advisory work, I see here, for the provincial departments?—We answer questions occasionally. I consider we have not done very much in that direction.

A.521. Do these Provincial Livestock Experts pay occasional visits to Bangalore in order to study these various lines of investigation?—No, they do not.

A.522. The most important experiment to my mind is your digestion experiment, and you have obtained the co-efficients which enable you to estimate the digestibility of cattle fodder and cattle foods. Now, are you undertaking a study of the relative values of Indian fodder and feeding stuffs?—At present, we are studying the relative value of all fodders by co-ordinated long-period feeding tests, and seeing how much fodder is practically required to maintain animals. That is the way we are comparing them at present; it is not a very accurate method; when we have more means, we will institute more accurate procedures.

A.523. But, nevertheless, this work is so important that the Provincial Livestock Experts ought to be interested; do you mean to say that they are not interested?—Again, I say we have worked here for 2½ years only. Before

a year and a half was over, we could not publish anything; we have now commenced to publish. People are perhaps beginning to know that we exist, and we hope to have a great deal of contact with these people later on.

A.524. You have published articles in the *Agricultural Journal of India* which I read with great interest?—I have published two articles in the Journal and two memoirs so far; it is merely a fraction of what we have to do.

A.525. You mention here that feeding tests may be carried out in any part of the country. Do you receive any requests from the Provincial Agricultural Departments for the purposes of such tests?—Fortunately, we have the Imperial Dairy Expert's farm at Karnal, which is always open to me, as everything of his is generously open for work; and we have carried out experiments there many miles from our headquarters; we have actually commenced another experiment this year.

A.526. So that, in view of this, shall I say, apathy of the Provincial Governments, you feel that co-ordination of some sort is necessary?—I do not wish to say that the Provincial Governments or the Provincial Departments are apathetic in the least. I do say that co-ordination is very important. I have pointed out the ways in which co-ordination will help the work, and I think of course the means must be provided for carrying out this co-ordinated work.

A.527. Do you think that the existing organisation is inefficient to bring about that co-ordination which you desire?—From my note, you will see that I consider it is inadequate, and I consider that the provision of these facilities for co-ordination will yield very good results as far as the nutrition of animals is concerned, and I believe they would act beneficially in other branches of research also.

A.528. Would you like to have an Advisory Council, functioning on the same lines as the Council does in England?—Yes; it would be advisory, with the proviso that there are acting committees under it.

A.529. No executive authority would be given to this Council?—It is hardly for me to make recommendations of that kind. If we give executive power, it would be all the better.

A.530. I raise this point because you say here " would arrange for the execution of co-ordinated work." That suggests that you are looking for executive authority vested in this Council. Do you think the Board of Agriculture is functioning in that direction as an Advisory Council?—Yes, for the purposes which we are thinking of; in co-ordinating work we want something stronger, and provided with funds and power for carrying out co-ordinated work.

A.531. Then you will not be satisfied merely with an advisory function?—I think it must be mainly advisory.

A.532. With regard to your *Sorghum* silage, what type of silage have you evolved? Have you evolved any particular form?—No particular form; I have just tested the ordinary *Sorghum* silage here.

A.533. Would your method be expensive for the farmers?—The cutting is an expensive item.

A.534. *Dr. Hyder :* I was wondering whether you, as Physiological Chemist, were also considering the question of the best method of preservation of the vitamin contents of such fodder, so that the vitamin contents of the milk and other produce may be preserved and increased?—There are many important questions which we would like to tackle, but cannot do so.

A.535. *Mr. Kamat:* On page 59 of your memorandum you say that the cross-breeding principles on which milk production at Bangalore is based are an endless trouble to the Nutrition Section. You also say there that the dairy only wants to have half-bred cows, and that their offspring is a useless mongrel, which they must sell. Do I take it that you disagree with this principle which the Bangalore dairy is following?—Not at all. The only thing is that it does not help me in getting the cattle I require for experimental purposes. They do not keep their calves because they are not very valuable to them, and we have not got as many animals as we would like for experimental

purposes. I have no criticism whatever to make with regard to the principle of cross-breeding.

A.536. So that, the complaint is only from the point of view of the experimental work?—That is all.

A.537. Not from the point of view of breeding or milk production?—Certainly not; I could not possibly criticise it.

A.538. And then the remedy you suggest at the end of that paragraph is to put the dairy on an experimental basis, which would enable it to breed and select animals. Will you please explain what that means?—If the dairy were breeding country stock, they would not mind keeping all the young animals, and I would thus have more young stock to work with.

A.539. You agree that this policy of selling the offspring from the cross-bred cows is the right one, which even private cultivators can follow?—I have nothing to do with that subject whatever.

A.540. You do not wish to express an opinion on it?—It does not concern me; I would rather not.

A.541. *Sir Ganga Ram :* What propaganda do you employ now to teach the agriculturists the value of your labours?—In answer to the Chairman I explained that I propose that all the results we obtain should be made known through the Agricultural Departments and not from me direct.

A.542. It has not been done so far in any shape or form?—No; I would rather not do that; I am not in contact with the agriculturist. I am doing experimental work, and I would make it known to the Agricultural Departments.

A.543. Are your reports secret?—Certainly not.

A.544. Is there any publication of these reports?—There is the annual report to be had, and there are other publications that we make, in the form of bulletins, or memoirs, or any articles in the agricultural journals.

A.545. Is yours the only Institute of Animal Nutrition in India, or are there any others?—There is an institute in the Punjab, which I mentioned, where work on animal nutrition is being done to a small extent.

A.546. Is that a subject of the College?—It is one of the experimental subjects.

A.547. Who is doing that?—Dr. Lander, Agricultural Chemist to the Government of the Punjab.

A.548. *The Chairman :* You would agree with me that the scientist who rushes into print before his results are ready for publication is rather apt to find that his reputation goes up like the rocket and comes down like the stick?—I agree with you.

(The witness withdrew.)

The Commission then adjourned till 4 p.m. on Thursday, the 11th November, 1926, when Mr. N. Rama Rao, Sericulture Expert with the Government of Mysore, was examined. It then proceeded to take evidence at Coimbatore from 13th to 16th November, 1926. For the evidence of Mr. N. Rama Rao and the first 6 witnesses (provincial) at Coimbatore see Volume III. The last witness to be examined at Coimbatore was Rao Sahib T. S. Venkataraman (Imperial) whose evidence follows.

Tuesday, November 16th, 1926.

COIMBATORE.

PRESENT :

The MARQUESS OF LINLITHGOW, D.L. (*Chairman*).

Sir HENRY STAVELEY LAWRENCE, K.C.S.I., I.C.S.
Sir THOMAS MIDDLETON, K.B.E., C.B.
Rai Bahadur Sir GANGA RAM, Kt., C.I.E., M.V.O.
Sir JAMES MACKENNA, Kt., C.I.E., I.C.S.

Mr. H. CALVERT, C.I.E., I.C.S.
Raja Sri KRISHNA CHANDRA GAJAPATI NARAYANA DEO of Parlakimedi.
Professor N. GANGULEE.
Dr. L. K. HYDER.
Mr. B. S. KAMAT.

Dewan Bahadur T. RAGHAVAYYA PANTULU GARU.
Rao Bahadur B. MUNISWAMI NAYUDU GARU. } (*Co-opted Members.*)

Mr. J. A. MADAN, I.C.S.
Mr. F. W. H. SMITH. } (*Joint Secretaries*)

Rao Sahib T. S. VENKATRAMAN, B.A., I.A.S., Government Sugarcane Expert, Coimbatore.

Replies to the Questionnaire.

QUESTION 1 (*b*).—**One obstacle to the realisation of the maximum benefit from the sugarcane breeding work at Coimbatore is the non-availability of sub-stations in the main sugarcane provinces of the country under the direct** control of the Coimbatore station.

The Coimbatore station is intended to produce, by breeding, improved types of seedling canes for every part of India. There are three essential requisites for the proper discharge of this function by the station : first, the actual production of the improved cane seedlings; second, the careful testing of the improved types with the indigenous kinds with a view to selection; and third, the distribution of the new canes to the cultivators.

Over 80 per cent of the Indian area under sugarcane is in sub-tropical India, where the canes do not generally flower, or even if they do, do not set seed. The breeding of canes for the whole of this region has, at present, to be done at Coimbatore in South India. The station at Coimbatore is now in a position to raise any number of seedlings and with most of the desired parentages. It may now, therefore, be assumed that there are no very serious difficulties as regards the first requisite.

The second requisite, *viz.*, the testing of the new canes in comparison with the local kinds and their selection, is at present done in two stages. The leading indigenous canes of Northern India are now acclimatised at Coimbatore and the new productions are compared with the indigenous kinds at Coimbatore itself and a preliminary selection made, of such as are distinctly superior to the indigenous varieties. This first selection at Coimbatore is made none too rigid, through fear of losing any that might ultimately prove useful, when actually grown in Northern India.

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The second, and by far the more important selection, has to be made in the locality itself and this is, at present, done in the Provincial Government firms. Experience shows that these testing stations could be divided into at least three different groups according to the manner in which the selection work is carried on.

We have, first, the class of stations which have an intimate knowledge of local conditions, know exactly which sort of cane will be an improvement on the canes in the locality,—are keen about the trial and spread of the new canes in the locality and are, therefore, only too eager to take full advantage of the Coimbatore work. Such stations render all possible help to Coimbatore in gathering complete data on the good and bad points of the new canes.

The second group comprises stations which are willing to do all they can to test and spread the new canes but are unable to do so for a variety of reasons, such as lack of adequate staff, time or space for properly carrying out the tests, or inadequate facilities for getting an intimate knowledge of the canes in cultivation in the locality. In some of these, the cane is one among the many crops needing the attention of the staff employed, with the result that it does not receive adequate attention.

There is a third group of stations which, for certain reasons, are not very keen about the Coimbatore canes.

There is thus seen to be a considerable amount of difference both in methods and in the standards adopted, by the various testing stations. When it is remembered, that the testing in the Provinces is the more important test in the selection of the improved seedlings, the disadvantage of the present arrangement would be obvious.

The remedy for the present state of affairs lies, in the opening of sub-stations in every major cane tract under the control of the Coimbatore station by the Imperial Department of Agriculture. The sub-station would be needed for each cane tract irrespective of the political boundaries as to Provinces. These sub-stations would carry the work a step further forward, *i.e.*, to the end of selection of the seedling for the locality and up to the distribution of the cane to the cultivators in the tract, which latter activity is best left to the Provincial Department of Agriculture.

There would be another very important advantage resulting from the founding of the sub-stations mentioned above. For the breeding work at Coimbatore to be carried on at its best, a considerable amount of knowledge is needed about the conditions of growth obtaining in the locality and a personal touch with the improved seedlings as they spread into cultivation. The founding of the sub-stations will secure both these conditions. Sugarcane is, generally, a paying crop and, if properly run, the testing station should be able to remit back as receipts, a fair portion of the monies expended on it. The sub-stations would be in a position not only to recommend the Coimbatore seedlings most suitable for the locality but supply besides a fair amount of material of the recommended seedling.

The proposed sub-stations should seek the full patronage and support of the provincial departments, because the satisfactory working of the sub-stations would depend a great deal upon the hearty co-operation between these and the Agricultural Department in the Province.

QUESTION 3 (*d*).—A striking instance of effective demonstration and propaganda is afforded by the work of the Sugar Bureau at Pusa in spreading into Bihar the improved Coimbatore canes. The Bihar work has further been partly responsible for attracting the attention of certain of the other Provinces to the merits of the Coimbatore productions.

The main feature in the work was the large scale tests which were carried out in the fields of the planters themselves. Besides being on a large scale, the tests were complete and based on results obtained by passing a full and sufficient quantity of cane through the factory and comparing the improved cane with the local variety in all its aspects from the sowing to the obtainment of

the finished product in the form of sugar. The thoroughness of the tests readily carried conviction to the planters who quickly adopted the new canes.

When the cultivator sees a demonstrated crop in a Government farm, he sees along with it costly machinery and other equipments—though these may be there purely for experimental purposes—and leaves the farm with a shrewd suspicion that the good results have resulted from other causes besides the ones mentioned. On the other hand, if he notices an appreciable difference in favour of a new variety in his own land and with cultural operations carried out by himself he readily takes up the improved strain.

Two other contributory factors to the success of the Pusa work have been (1) the presence in the locality of an enlightened set of planters who had given up the indigo crop and were eagerly on the look out for another to replace it and (2) the personal keenness of Mr. Sayer, the officer in charge, in pushing the new Coimbatore canes into cultivation.

Enlightened planters like those in the white sugar belt of Bihar are not generally available elsewhere. It is my experience, however, that the ordinary cultivator is not quite as conservative as he is at times represented to be. Once he sees a good thing and sees it in a manner which readily carries conviction to him, he sometimes goes even beyond the limits demanded by caution. I have had such experiences in connection with the improved Coimbatore seedlings.

QUESTION 4 (*a*).—A greater co-ordination of agricultural research in the Provinces, than is available at present, is desirable. I have known instances of experiments started in a Province, without any idea of the results as obtained from the same experiment elsewhere. I am not against the same experiment being conducted in more than one Province. The variations in climatic and other factors, that are found within a continental country like India, render such experiments useful and desirable; a greater touch between the workers will conduce to greater efficiency and quicker results.

With the steady advance that is being made in the direction of provincial autonomy, the Provinces are likely not to support, if not to resent, any central organisation other than of a purely advisory character. To be useful, any central organisation should be so developed as not to suggest any idea of domination or dictation to the Provinces in the matter of agricultural research. With the Reforms the situation needs a rather delicate handling. Facilities for a more frequent meeting in conference of experts working on the same subject, and a small central board consisting of experts as well as of the leading interests in agriculture and allied industries, might meet the situation. The touchiness of the provincial departments should be satisfied by including in the board senior men from the Provinces as well. Such a board need not necessarily involve much additional expenditure, as the members could be made to serve in an honorary capacity. This board could periodically get the programmes of work from the various Provinces and might function both for co-ordinating research and for offering advice on matters of importance.

(*b*) The department under the Central Government should be so developed as to carry a full complement of expert staff in all the branches of agricultural science. It is true Agriculture is a Transferred subject in the Provinces and rightly so after the Reforms. Many of the problems dealt with in the Provinces are best studied in the localities themselves. The scientific officers in the Provinces are apt to be pre-occupied with local needs and work with a view to comparatively quick results. Research into the fundamentals of the problems involved is best tackled by a central department.

There are certain problems such as " The Indian Sugar Problem " and the rather important work of " Plant Introduction " which are best handled by the department under the Central Government.

The data here given would show that the improvement of sugarcane varieties in India could not have been done efficiently by any agency other than a central department. Some of the poorest canes in India are those found in the unirrigated tracts of the Punjab and the largest cane area in India is in the United Provinces. The sugarcane does not flower in either of these regions

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but does so freely in the Madras Presidency in South India; and, in this Province, the cane occupies but a subordinate place among the crops of the locality. The regions most to benefit from cane breeding are thus precluded from undertaking any work in this direction; whereas, the Province in which the cane flowers freely, would not feel justified in going in for any large expenditure on the crop. If the Central Government had not started the Coimbatore Sugarcane Breeding Station, it is difficult to see how else the improved seedling canes for the Punjab, the United Provinces and Bihar would have been secured; very likely the work would not have been undertaken.

The Central Department, while primarily intended for the country as a whole, should be able to bring its superior resources to bear on any particular problem which might have become suddenly urgent and important in any of the Provinces. Any existing indifference of the Provinces towards the central department would disappear after a few definite demonstrations of help and co-operation to the Provinces as indicated above.

It is purely an accident that Pusa in Bihar happens to be the headquarters of most of the agricultural research work under the Central Government. There are certain problems which are better studied in localities other than Pusa. When such a problem arises, the central department should be able to found a station in the Province and carry work on its own account. The location of the Imperial Sugarcane Breeding Station at Coimbatore is a striking example of the usefulness of such an expansion.

(*c*) (*i*) The services rendered by the Indian Agricultural Service are satisfactory, though capable of improvement in sundry directions. The recent Indianisation of the service—that has followed from the recommendations of the Lee Commission—has not in my opinion detracted from its efficiency.

Indians in the department have at the start relatively more difficulties to contend with. For one thing their work takes longer time for getting recognition in the country. I know of instances, where such work received recognition outside the country earlier than within it. So long as the Indian recruit is properly and carefully selected, there need be no fear of loss of efficiency.

It is hardly six years since anything like an effective Indianisation was initiated and that too in but a few of the Provinces. To condemn this policy as leading to inefficiency within such a short period is totally premature. Even new sugarcane seedlings need a longer time to judge of them with any claims to accuracy.

Greater opportunities should be given to the officers of the department to see work elsewhere both within the country and outside of it by affording such facilities as deputation and study leave.

Any foreign training needed for recruits into the Indian Agricultural Service is best given after some service within the country. This would enable the individual to get a good grip on the problems that he will be faced with after his return to the country. The Indian Universities are rapidly developing in equipment and efficiency and the need for foreign training would steadily disappear with the advance of time.

The short-term system of recruitment is not of general utility in the case of the Agricultural Department. It would involve greater expenditure to the State without compensating advantages. Its use is confined to cases where a costly specialist has to be employed in connection with problems which are capable of solution in a comparatively short period of time. The problems presented to the agricultural researcher often need a long period of attack for their proper solution.

QUESTION 9 (*a*) (*i*) AND (*ii*).—With the progress in breeding, a new line of work would appear to have opened out in connection with the reclamation of waste or alkali lands. A sugarcane seedling obtained at Coimbatore by hybridisation with a wild grass, has shown a marked capacity to grow under adverse soil conditions; the ability has apparently been derived from the wild ancestor.

The reclamation of waste and alkali lands could now proceed from two directions; one, by acting on the soil and second, by breeding a strain which

would grow under adverse soil conditions. Certain root studies by the writer have shown a definite promise in this direction. Once a barren land gets accustomed to vegetation, of however poor a quality, it would appear to be easier later on to accustom the land to more remunerative cropping.

QUESTION 11 (*a*) (*i*). I would urge the appointment of crop specialists in the case of the more important crops in the country. It is only at the hands of such a specialist that the crop would get the attention it needs. The pure scientists have often a tendency to look at the crop piecemeal and from the view point of their own science. The crop needs to be studied as a whole for rapid progress in its improvement under cultivation.

(*c*). A striking example of successful crop improvement through breeding is afforded by the work of the Sugarcane Breeding Station at Coimbatore. This day and within about a dozen years after its founding by the Central Government, its productions are rapidly spreading into cultivation in every Province to which they have been distributed. The published departmental reports are replete with references to their merits.

I have made an attempt, to obtain from the District Officers, an idea of the increased money value resulting from the spread of the improved Coimbatore canes in place of the indigenous varieties. The figures for the last season are :—

(1) An increased profit of a lakh and a quarter of rupees in Bihar.

(2) A lakh in one circle in the Punjab.

(3) A third of a lakh in one circle of the United Provinces.

It is just nearing four years since the Coimbatore canes got into cultivation and the above figures are bound to increase very rapidly with the advance of time.

One of the Coimbatore productions—Co. 281—has shown " extremely favourable results both as regards tonnage and sugar contents " in Cuba. It is said to have stood " easily the first in sugar " and " very high in tonnage ". It is thus possible that, as time advances, the utility of the Coimbatore work may extend beyond the limits of the country.

QUESTION 13 (*i*). The Act now in force against the importation of sugar-canes from foreign countries is fairly adequate, though there exist possibilities of evading the Act in sundry ways. A quarantine station, for receiving new introductions and growing them for a period under strict control before passing them into cultivation or for breeding, is likely to be needed in the near future. Most of the other cane countries of the world now possess such a station.

(*ii*). The breeding of disease resistant strains opens out a new, efficient and promising line of work for protecting crops against infection from any particular disease.

QUESTION 17 (*d*). The Indian Sugar Committee recommend the starting of a model sugar factory by Government in a suitable place (*vide* page 330 of their Report). At present Indian capital is rather shy of investment in sugar concerns. The establishment of a Government factory, carrying on research work on the various operations, and the publication of reliable data from time to time will stimulate the flow of capital into such concerns. This is a necessary step to make India self-contained in the matter of sugar.

R. S. T. S. Venkatraman.

Oral Evidence.

A.549. *The Chairman :* Rao Sahib Venkatraman, you are the Sugarcane Expert to the Government of India?—Yes.

A.550. You put in a very interesting and instructive answer to the Questionnaire issued by the Commission. Would you rather make a statement of a general character at this stage or shall I proceed to question and answer at once?—I have no statement to make.

A.551. The Commission has of course in mind the very interesting exhibition which you arranged at the sugarcane station the other day?—Thank you.

A.552. And we are also grateful to you for all your arrangements. Would you give the Commission quite shortly the story of your professional training?—I am a Botany graduate of the Presidency College at Madras, having been a prizeman and placed in the first class. After that I had about 18 months' training as a post-graduate scholar in the same college; I was drafted into the Agricultural Department under Dr. Barber who was then the Government Botanist. I entered the department in the middle of 1907 and I had experience of teaching for one year. From 1908 to 1912 I was doing research work on various crops as cotton, *gogu* and also certain garden plants like *mirabilis* and other plants under Dr. Barber. In 1912 when the Government of India were starting the Imperial Sugarcane Breeding Station, Dr. Barber selected me to work under him and with him. I have been associated with Dr. Barber from the very commencement of his experiments on sugarcane breeding. I might perhaps mention that experiments were started in sugarcane breeding a year earlier than the creation of the post of Government Sugarcane Expert itself; because even as Government Botanist, Dr. Barber devoted attention to this work. It was certain preliminary results, obtained, even before the Sugarcane Station materialised, that induced the then Board of Agriculture to definitely recommend the starting of a Sugarcane Station. From 1912 till 1918 I have been working under and with Dr. Barber in connection with cane breeding. From 1918 onwards I have been in independent charge of the station. That brings it up to date.

A.553. To proceed at once to the central point of your proposals, I understand from your memorandum that you look with favour upon the setting up, in every major sugarcane tract, of stations linked with this Coimbatore Station, I suppose under the general direction of yourself, each station applying itself to the immediate problems of its own district?—Quite so. Only, the sub-stations which I have in mind are intended to grow the seedlings produced at this place and carry the work a step further. If I may explain, at present, sugarcanes do not flower in Northern India and therefore the seedlings have to be bred at Coimbatore. From here we send only setts or cuttings and this station being far removed from the main sugar tracts of this country, the selection made here has to be of a preliminary character; we dare not reject too many, for fear of losing some which ultimately may prove of use in the Provinces. The sub-stations, which I am contemplating, would grow these seedlings, look after them and carry the work of Coimbatore a step further. I expect, these sub-stations would shorten the work of this station by about four to five years in the attainment of results in the Provinces.

A.554. I seem to see also in your note of evidence some indication that you are not perfectly happy in your own mind as to how this proposal, which you have been enlarging upon, would be received in the Provinces within whose boundaries these stations will be situated?—I do not expect any difficulties so long as the Provinces are not asked to provide the funds.

A.555. You think that, if you are allowed to exercise your tact, and provide the funds, you will overcome all resistance?—I should think so.

A.556. I want this from you in particular; in your view is the fact that this is one of the few districts in India, where sugarcane will flower, a reason

for breeding that crop in a different fashion from the standard methods, according to which, you would suggest dealing with other crops?—Yes, it is so.

A.557. So that, if I have made my question clear, you would not suggest central research or plant breeding stations reproducing themselves in every typical district throughout India, as organisations financed by and responsible to the Central Government. You would not suggest that as to crops other than sugarcane?—Not on the breeding side, no.

A.558. On the research side you would?—I should suggest Central Government Stations.

A.559. Central Government Stations?—Central Government Stations with regard to some of the major crops, to go into the fundamentals of the problems involved in connection with the improvement of each crop.

A.560. You are impressed with the success of the principle of organising research crop by crop?—Yes.

A.561. What do you think of the work of the Indian Central Cotton Committee in that respect?—I am not much acquainted with the work of the Committee; I hear it is doing very good work, but I have no direct touch with it.

A.562. I should say from certain internal evidence in your note that you have applied yourself in some detail to the system of organisation as between the Federal Department and the State Departments in the United States of America, am I right?—Yes.

A.563. Do you like the plan as it is working in America?—Yes, that is the idea.

A.564. That plan involves the spending of Central Government funds partly in Central Government Institutions and in the Provinces or States as in America, and even in institutions owned and conducted by the Provincial Services?—Yes.

A.565. Experience has shown that co-ordination in America is essential and so inter-state jealousies and the natural jealousy of the Federal Department towards the States or of the States towards the Federal Department has been overcome in the interest of agriculture as a whole?—Yes.

A.566. You would not suggest a system such as that in every detail for India, would you?—Not in every detail but in the broad outline.

A.567. You would?—Yes.

A.568. This is the point we are concerned with. Would you suggest the spending of Central funds in provincial research institutes?—I do not think there is any harm in it.

A.569. Do you know that in America when the Central Government so spend money, they claim and exercise the right of inspection?—Yes.

A.570. And you do not mind that I should like to have that privilege for the Central Department, but I do not know how the Provinces would receive it?—But so long as a certain amount of money is provided by the Central Government I expect no difficulty.

A.571. You are impressed with the importance of co-ordinating research work on crops throughout India?—Yes.

A.572. And you regard these problems as All-India problems and not as mere provincial problems?—Yes.

A.573. Have you any idea how funds might be made available for the Central Government without which co-ordination with the Central Government would not be attractive to the Provinces?—I have not thought about that.

A.574. Without taking you through the details of your note, or the work that you are carrying out, the Commission would like to have on the notes your own views as to the reasonable probabilities of improvement in sugar yields in India in the measurable future?—For a long time it was considered by sugar authorities, that the Province of Bihar, where are centralised almost all the important Indian sugar factories, was not likely to be able to grow a decent variety of cane. But the breeding work that has been done at Coimbatore has

shown that, even in that Province, we could grow crops perhaps as good as Java. That being the case, I am indeed very optimistic about the future position of sugar, provided Government and the legislatures guarantee the necessary facilities.

A.575. By that you mean the funds for carrying out work?—Funds for carrying out research and also, if necessary, any protection to Indian sugar. In this connection I would like to say that some of the other countries in the world have had a start over India of about 60 or 70 years so far as sugar production is concerned. It will take sometime before we are able to get our factories up to anything like the standard of other countries. As an infant industry it is just possible it may need a certain amount of special protection from Government.

A.576. What proportion of the refined sugar consumed in India is imported? Can you say approximately?—I know the value of the imported sugar, but I cannot give the exact proportion.*

A.577. Are you sure that a very important proportion of the refined sugar consumed in India is imported?—It is imported; in fact the money value of the imports in sugar comes almost next to clothing.

A.578. So that an import duty on sugar would have the effect of raising the cost of refined sugar to the consumer; that is your intention, is it not?—Yes.

A.579. Is it your idea, that a demand would spring from that cause, which would lead to more Indian sugar being refined, or are you thinking of a bettering of the *gur* market?—I do not very much like anything which would lead to an expansion of the refining of the indigenous *gur* because it leads to considerable waste; I should like to see development in the direction of more factories producing sugar direct from cane.

A.580. In making your recommendation for a protective duty, you have yourself fully considered the rather difficult economic problem as to whether any duty of that sort would assist the grower of sugarcane in this country, since the cane which he grows is in the main converted, not into sugar, but consumed as *gur*?—Yes.

A.581. Do you think it is a complicated problem?—Yes; it is a complicated problem.

A.582. Have you fathomed it fully yourself?—No.

A.583. On my original question, you do look forward with confidence to a very considerable increase in the yield of sugar per acre?—Yes, I would quote the instance of Java which has been able to treble its yield per acre within 60 years. I do not see any reason why in India we should not be able to do it; our station has shown that it could be done.

A.584. Do you think Indian sugar production will require protection or subsidy or some such crutch for all time, or do you think there are conditions which at this moment favour foreign competition?—This protection will certainly be needed only for a short time, because I see that in India we have greater facilities, probably, greater than in certain other countries of the world, so far as the cost of production of a ton of cane is concerned.

A.585. Have you studied the conditions in Java?—I have not been there.

A.586. But you have read literature on the subject?—Yes.

A.587. Do you think that natural conditions there, apart from the act of man, are very much more favourable to the growth and better yield of cane than are conditions in tropical India?—It is rather a controversial question, but my own personal opinion is that our conditions are such that we should be able to produce in India sugarcane cheaper than Java.

A.588. So that, all you are asking is some assistance for a limited time so that you may have the opportunity of establishing improved conditions?—Yes.

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*About 87 per cent of the refined sugar consumed in India is imported from abroad.

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A.589. How much do you hope for from the improvement in extracting and manufacturing processes?—If the modern sugar factories were to be in operation in all places where at present *gur* is made (by *gur* I mean the indigenous crude product) on a rough calculation we shall have 30 per cent increase in extraction of the juice from the cane. There are, however, difficulties against the starting of modern factories everywhere.

A.590. Extraction by better machinery?—By factory machinery in place of the machinery used by the cultivator.

A.591. Would that give an increase of 30 per cent in the yield of sugar?—We are losing 30 per cent at present.

A.592. *Sir Henry Lawrence:* Sugar or juice?—30 per cent of juice.

A.593. *The Chairman:* Is that the same thing as 30 per cent of sugar?—No, because in the method of manufacture we are again losing perhaps another 15 per cent; so that we are losing at least 40 per cent. because of the crude methods of manufacture adopted by the cultivator.

A.594. You are doing your best to do your share in the way of improving varieties of cane?—Yes.

A.595. Do you think that other people are doing their share in the way of improving the processes?—Almost all the Provincial Departments are now engaged in effecting improvements upon the manufacture of the crude product, that is *gur;* but I do not think there is much activity towards the establishment of modern factories.

A.596. How do you account for that lack of activity?—For one thing a factory means a lot of investment of capital; that is why I advocate, towards the very end of my note, the establishment of a Government factory which would be able to publish reliable data. I believe that is likely to encourage the flow of capital into sugar concerns. At present Indian capital is rather shy of going into sugar concerns.

A.597. You do not think that anything in the nature of a duty would remove the stimulus to some extent which tends to promote improvement in processes?—In fact, I should be very careful in deciding what duty to put on and for what period, because if the duty be too prolonged, our factories will continue to be inefficient. Within recent years I have reliable information to show that the factories have greatly improved from 6 per cent extraction to almost 9 per cent.

A.598. In saying that of course you are assuming that your notion is right that a protective duty will in fact afford certain help?—Yes.

A.599. Although in conversation just now you agreed with me that that was a very difficult matter to decide?—It is a difficult matter.

A.600. Can you tell the Commission what proportion of the total area under sugarcane is under Coimbatore canes to-day?—It is difficult to give anything like accurate figures, but I can quite easily give the money value, because I have gathered that information from the district officers. The acreage I would put roughly at at least 12,000 acres; that is very rough.

A.601. Twelve thousand acres under Coimbatore canes?—Yes; that is the sure minimum figure, a figure of which I am quite sure; it may be more; it is a very conservative estimate.

A.602. What is the total acreage under cane in India?—In the whole of India it is $2\frac{3}{4}$ millions of acres. In this connection I have to mention that it is hardly three or four years since the Coimbatore canes got into cultivation, and as in all these cases the increase hereafter will be very rapid, the proportion next year may be five times this year, the year after it may be five times that again, and so on.

A.603. That is all cane bred here?—Yes.

A.604. There are certain areas for which you have not yet bred suitable canes, are there?—Yes.

A.605. You hope in the future to meet that demand?—Yes.

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A.606. You are, officially, in the position of being a guest in the Presidency of Madras, are you not?—Yes; a sort of guest.

A.607. Do you suggest that you are paying something for your board?—Yes, I have just started paying for my board, because the Government of India have given me 38 acres to start work on the type of canes suitable to the Madras Presidency. I have always been in an awkward position, because my visitors are all from Madras Presidency. These visitors come to me and ask whether I have bred any cane suitable to their areas, and when I say all the cane is for the Punjab and Northern India, they say "you are a useless fellow." Hereafter, I am glad to say I will be able to show them cane suitable for Madras and Bombay.

A.608. You are now mending your ways and you are going to try?—I am trying.

A.609. I understand that Madras is also moving, and that they propose to set up their own cane breeding station?—Not a cane breeding station, but a cane research station.

A.610. Not a cane breeding station; they will depend upon you for that?—They will.

A.611. You think so?—They have to, more or less. With regard to sugarcane I am in rather a fortunate position, and that is there are so many cane localities in Northern India where sugarcane will not flower, and there are other places like Bombay and North Madras where it will, but do not produce fertile seeds; and I am not sorry for that.

A.612. But after all, you are not against other Presidencies setting up their breeding stations?—I do not mind.

A.613. I am only trying to get at the facts?—I do not think they will.

A.614. Is it agreed between you that they will depend upon you for breeding?—I think they will.

A.615. There is nothing fixed in writing?—No. In fact there is, I think, already an informal understanding. The Deputy Director has already sent up proposals to the head of his department in Madras in connection with the sugarcane research station. We have an informal understanding and we have agreed beween us that I should do the breeding and he should do the rest.

A.616. How came it that you tackled the requirements of Northern India before you tackled the requirements of Southern India?—Because the bulk of the area is in Northern India. The total acreage in India is roughly 2¾ million acres, of which half a million is in the Punjab, half a million in Bihar and Bengal, and 1¼ million in the United Provinces. Therefore I am trying to produce cane for a tract that is growing 2¼ million acres out of a total of 2¾ million acres; there I am perfectly justified. In the beginning, if you will permit me to say it, we wanted to make an impression as soon as possible on the Indian sugar problem. My station was in the first instance sanctioned for five years; if I did not show any result I would have had to go. Then, it was sanctioned for another five years. Therefore, we were anxious to show the maximum result within the shorest time, and we did show a definite result within eight years of the founding of the station.

A.617. Are you hopeful of making any substantial contribution to the sugarcane problems of Southern India?—Situated as I am at present, I do not propose to tackle any of the other problems pertaining to Southern India; but if I am wanted I could do it.

A.618. Provided you are given the staff and the money?—Yes.

A.619. Have you adequate staff to deal with that at the present moment?—No.

A.620. *The Raja of Parlakimedi:* Has a geographical survey been made of the sugarcane producing areas in India?—In the Statistical Atlas there are published figures showing the acreage of cane in every Province and in every district throughout India.

A.621. Roughly, what is the area?—2¾ millions in the whole of India.

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A.622. What is the area in this Presidency?—It is about one-tenth of a million.

A.623. What is the area at present under cane, both of improved varieties and indigenous varieties in this Presidency?—I have not been doing any work for Madras until now.

A.624. The figures have not been supplied to you. Are they available?—The figures are available, but I did not interest myself in those figures because I was not doing any work for Madras.

A.625. Are you in touch with other parts of the world where sugarcane is grown or sugarcane research is conducted?—I am in touch through correspondence the work done at Coimbatore has now attracted world-wide attention; other people who are working in the same line are corresponding with me; that is the only touch. I have never been outside India.

A.626. But you are taking advantage of the research work done in other parts of the world?—Of course; I am feverishly trying to get all the information I can from all over the world.

A.627. When you are creating these different varieties of canes, what are the main factors to which you pay attention?—At present, I am concentrating most attention on what may be called the tonnage of cane per acre. Other things being equal, the tonnage of cane per acre, that is the quantity or weight of cane cut per acre, is the main thing.

A.628. What about the sucrose in it?—I try to make improvements on sucrose also, but I think the best way of producing early results is to work on a tonnage basis. Of course, I see that the quality I produce is not worse than the quality we already have.

A.629. So that you have not succeeded in improving the proportion of sugar from the cane?—No; I mean the total quantity of sugar produced per acre from some of my canes will be two and half times the quantity raised from local canes; I have the actual figures.

A.630. What about the proportion of refuse, when compared with indigenous canes?—As far as the canes which are now spreading in Northern India are concerned, in some cases the refuse is more, and in some the refuse is less. In fact, I have had complaints with regard to certain of my canes, that they were too good in that they did not give enough fuel. My reply was " I am trying to breed cane for sugar and not for fuel."

A.631. Have you successfully tackled the well-known diseases, such as stemborer, redrot and so on?—I have nothing to do with diseases, though I have tried to get a knowledge of them; I am not directly working on diseases.

A.632. Do you not think it is an important thing?—I am working more on the lines of producing varieties resistant to disease.

A.633. But it is necessary to know the life history of the diseases?—I do not know the life history of the diseases in detail, but I know the main factors of certain of the important diseases.

A.634. Then, in a way, you do tackle the difficulty?—I do, from the breeding point of view.

A.635. So far, is anybody in Southern India taking advantage of this station?—I would not exactly say that they have taken advantage of it. I have not been doing much work for Madras yet, but even now one of the canes produced originally for Bihar has done well at Anakapalle, and I read in one of the monthly digests published by the Agricultural Department, Madras, that Co. 213, which is popular in Bihar, has been found to be useful as a drought-resisting cane at Anakapalle.

A.636. But you do not entirely close your doors to Madras demands?—No. I am like a merchant who has got wares for any kind of customer. It is for the customer to choose whatever he wants; I am trying to increase the range of my wares. I have got the cane, which needs large quantities of irrigation, the planter's cane, the rich man's cane and the cultivator's cane; that is my idea.

A.637. *Sir James MacKenna:* Do you think there is any scope for the medium Coimbatore canes, such as Co. 213, in the Bombay Presidency?—I think it is distinctly worth a trial.

A.638. Have they not tried them yet?—Not yet.

A.639. Why not?—The farm at Manjri does not easily favour a cane which is thinner than the Pundia cane to which they are accustomed; but I think it is distinctly worth trying.

A.640. Because Pundia requires very heavy manuring and heavy cultivation, and therefore it is not a poor man's cane?—Co. 213 is not a poor man's cane.

A.641. It is a luxury cane?—It is the ordinary cultivator's cane; in fact, it will probably require much less water than Pundia itself. In this connection, I might mention that Java which once plumped more on the thick canes is now turning towards medium canes, and if the ryot wants a sure crop, my canes will help him better.

A.642. Have the Bombay Government approached you to provide them with improved varieties of canes?—If I may say so, that is one of the Provinces, I am sorry to say, which has not been very cordial towards Coimbatore.

A.643. Barring a few exceptions, are all the Provinces assisting you in conducting tests of your canes adequately?—I would not say all the Provinces. Most of them are.

A.644. Have you had any refusals from any other Province or have they shown lack of interest?—It is not exactly refusal; want of cordiality is enough. For example, these canes have to be tested, and unless the local officer is very cordial, I should think twice before giving him a cane of whose merits I am not certain. If it does not turn out satisfactory, he will at once say, " The Coimbatore man has given this cane and see what has happened to it "; therefore, they must be absolutely cordial.

A.645. So that the lack of cordiality is an incentive to produce a higher standard. Are you co-operating in your main research work with the Scientific Section at Pusa?—Yes.

A.646. Both Mycological and Agricultural?—Yes.

A.647. What about your successor? Is that not an important matter?—Yes.

A.648. It is a very important matter; what arrangements are being made for a successor capable of carrying on your work at the same high standard?—There is a second officer, who has already joined; he joined six months back, and if I live up to 55, he will be working with me for 12 years; that is quite ample, I think.

A.649. Are you going to send him to Cambridge, or are you going to keep him in your own hands?—That again, is a point; sugarcane breeding differs in essential respects from other crops; there is no question of Mendelian ratios to speak of. We are just beginning to have indications of Mendelian ratios; only six months back we got something like an indication. I do not think a visit to Cambridge would be of much use.

A.650. That is your personal view?—That is my personal view.

A.651. So that, you think, with 12 years' training this man will be able to carry on the Barber and Venkatraman traditions?—Yes.

A.652. *Sir Henry Lawrence:* What has been the effect of recent changes of price on the area cultivated for *gur*, either in this Presidency or in other parts of India?—I have not studied that question much; I should not like to hazard any figures except this general statement that the area sown varies according to the market price of *gur*.

A.653. You have shown us some very interesting charts, giving the importation of Java refined sugar, and I understood that you wished to have measures taken which would reduce that importation?—Yes, and stop it ultimately.

A.654. On the ground, amongst other things, that it caused a large efflux of money from India?—Yes.

A.655. Rs. 15 crores?—Yes, 15 crores is the average for ten years.

A.656. Since you prepared that chart, which gave an importation of 450,000, the importation has in fact gone up to 700,000 tons?—It has.

A.657. Is there any office from which we can obtain information to show what is the effect of this importation of refined sugar on the cultivation of cane by the ryot?—The only office I can think of, which might give this information, is the Sugar Bureau at Pusa.

A.658. The price of *gur* has been fluctuating?—It has.

A.659. In this Presidency?—Yes.

A.660. Does it fluctuate in any relation to the price of imported refined sugar?—It does.

A.661. Can you establish a relationship?—There is a general relationship between the price of *gur* and the price of sugar in the market.

A.662. So that, large importations of Java sugar are likely, in your opinion, to reduce the price of *gur*, and thereby reduce the incentive to the cultivator to grow sugarcane?—Yes.

A.663. You have no very definite opinion on the point?—No.

A.664. You have not worked it out?—No.

A.665. Nevertheless, you are now proposing a protective duty against refined sugar?—Yes.

A.666. On what do you base that proposal, if it is not for the protection of the cane cultivator?—It is for the protection of the Indian sugar industry, which includes the cane cultivator as well as the factories that may come into being.

A.667. But the factory industry in India, you will agree, is very small as compared with the interests of the cane cultivator?—I should like to see the factory industry grow. Unless we expand the factory industry, we will continue to lose in the manufacture, and all the good work done in other directions will be lost. In these days, it is impossible to go on producing sugar under the old methods, because they are wasteful methods of manufacture; we have to be up to date, we have to be abreast of the world.

A.668. Do you find, then, that in this matter of waste, you are against factories which are making refined sugar from *gur*?—Yes.

A.669. Is that the practice in any factories?—No, not in many factories in Northern India.

A.670. Do they not make their refined sugar direct from the cane?—Yes, in Bihar most of the factories make sugar direct from the cane; that is the economical way of producing the sugar.

A.671. What is this waste that you complain of?—It is like this; if you had a ton of cane and produced sugar direct from it, you would get much more than if you had the ton of cane converted first into *gur* and from the *gur* into sugar.

A.672. Quite true; but where do you find this refining from *gur*?—Even here, in Madras, there are one or two factories which are doing the refining from *gur* on a small scale; there is one at Samalkot, there is one at Tinnevelly and there is one at Unao.

A.673. Is that a large proportion of the total amount of refined sugar made in India, that is, of 100,000 tons? How much of that is made from *gur* and how much from the cane?—I do not know the accurate figures, but it is not a very large proportion.

A.674. Talking of this Coimbatore cane in its applicability to Bombay canals, you say that the Manjri farm has not been very cordial towards your cane; does that mean that they have reported that your cane has not done any good?—Not exactly that.

A.675. That would be lack of cordiality; would it not?—I would not call it that. If they really found it bad and threw it away, I would have no objection. I am producing every year 2 lakhs of new varieties, and the bulk of them will be thrown out somewhere; I do not mind.

A.676. You complain that they have not tried your canes?—I might probably mention the actual case. When I go up to Manjri farm sometimes I am not allowed to go through their cane crops except with the officer and in one instance I had to wait two days sending out telegrams, doing nothing; I was at the Manjri farm but could not see the canes.

A.677. What is the year?—I do not remember the exact year.

A.678. Is it five years ago, ten years ago?—Probably about six years ago; it is probably better not to give the exact date.

A.679. That discourages you from going on?—Yes.

A.680. *Sir Ganga Ram:* In your experiments do you keep a record of the water that you use? What quantity of water do you use?—We do not carry out any definite experiments on the water requirements of the sugarcane. But on this Coimbatore station I am using something like 100 or 120 acre inches of water.

A.681. How much water do you require for 100 acres?—Our figures are on acre inches as we call it. In an irrigation, if the cultivator allows an inch of water to stand in the field, it is called an acre inch. It is based on something like the rainfall.

A.682. You use how much water, 100 to 120 acre inches?—Yes.

A.683. Do you know that in Bombay your cane is not making any headway?—Not yet.

A.684. Why?—The Bombay people are quite accustomed to the thick type of cane and the canes I have bred so far are all either thin or intermediate. I have yet no thick canes bred from the Coimbatore farm to give them.

A.685. Why have not the United Provinces, who are chiefly sugarcane growers, taken them up?—They have; the Coimbatore canes are spreading rapidly in that Province.

A.686. They are spreading?—Yes, and with the advance of time they will cover every acre there almost.

A.687. You are not charged for water here?—No, because it belongs to Government.

A.688. It is free?—We pump most of our water from the wells. I have to pay for the pumping; I have an oil engine.

A.689. The ryot also does that. In certain places where they have facilities for working from the canal, water-rate is charged. How much are they charged? That is what I want to know?—That I cannot say. In my farm I do not use much canal water.

A.690. Do you grow any coarse paddy which harvests in two months?—Paddy is not my line.

A.691. You do not grow any sugarcane which matures in two months?—I have not heard of a cane like that.

A.692. What do you advise the people to grow after you take the sugarcane off the ground?—I would not advise them because I do not know the local conditions.

A.693. What is the practice?—That differs in various places.

A.694. Do they put sugarcane after sugarcane?—No.

A.695. They do not?—No.

A.696. They put something else?—Yes. They put something else generally.

A.697. They do not put cotton? The best thing is to put cotton?—No; they do not.

A.698. Can you tell me with regard to a crop of sugarcane, what chemical properties does it take away from the soil?—I have not worked in that line.

A.699. *Sir Thomas Middleton:* You gave us the opportunity of seeing your work. You pay very great attention to the root development of your cane? —Yes.

A.700. It is from the root development that you judge whether cane is suitable for light soil or heavy soil?—Yes.

A.701. You have already indicated that you are growing an intermediate or thin type of cane. What is your ideal diameter in your intermediate cane? What size are you working on?—Somewhere between ¾ inch and 1 inch.

A.702. For your thin cane, what standard do you take?—Less than ¾ inch.

A.703. What height do you work up to? What is your ideal height for these different types?—That again is rather a complicated problem. It all depends upon the locality. If I want to introduce a cane to a locality where there are high winds I would not try to produce a tall cane. I would rather make up the tonnage by a greater number of canes to the field; it all depends upon the locality.

A.704. I expected that type of answer. But I was going to ask you what are the limits between which you work? For these districts where the winds are high you would select canes how many feet in height?—I should like to put it as low as 12 feet, but at present probably it is practicable to put it at about 15 feet high.

A.705. For districts where the winds are high?—Yes, 15 feet.

A.706. And how many canes from the stool do you consider sufficient?— That again depends upon the locality and upon the amount of seed I can get to the acre. I would on an average put it at about 8 to 12 canes to the stool.

A.707. What I was getting at is this; certain of your canes are free tillering varieties and certain are not?—I have both types.

A.708. For those localities in which you have high winds you want a free tillering variety?—Yes.

A.709. And a free tillering variety you describe as 8 to 12 to the stool?—I would rather put it at 12 to 16 for very free tillering varieties.

A.710. Let us now take the other extreme, the locality in which you want a tall cane. What size do you aim at?—It may be anything, in fact over 20 feet.

A.711. What is the maximum height of the Java canes? Can you tell us? —By the cane I must here mention I mean to the tip of the leaf.

A.712. Yes; what is the maximum height you know of the Java canes?— There are some Java canes which are only about 12 feet. There are other Java canes from 12 to 15 feet. Some of them are even 20 feet.

A.713. For certain districts you are growing much taller canes than the Java canes?—Yes.

A.714. When you grow the taller canes what amount of tillering do you want?—If it is a very tall cane, I would not go beyond four or five tillers.

A.715. Even in the places for which you are now working you have quite a number of different qualities to satisfy?—Yes.

A.716. Although you have as yet done very little for Bombay?—Yes.

A.717. Now coming to the next point, when you are making a cross how many fertile seeds do you aim at getting from one cross?—A sugarcane has got a very large number of flowers and in one pollination I can pollinate all.

A.718. But you do not do that, do you?—I do it on four different days.

A.719. Then you get from each process a very large number of seeds?—A very large number.

A.720. Do you actually grow all the seeds?—Up to about six weeks, all of them.

R. S. T. S. Venkatraman.

A.721. How many crosses do you make in a season?—It all depends upon the nature of the season. In a favourable season I make about 30 or 40 combinations. The number of crosses will be more.

A.722. How many thousands of seedlings?—I generally raise every year about 2 lakhs of new seedlings.

A.723. And is it the case that no one seedling is identical with its neighbour? —I have got accurate data with regard to a particular sowing where from a single flower, that is without any foreign pollination, we grew 2,700 seedlings and no two of them were alike. We described them with 30 or 40 botanical characters and none was like the parent.

A.724. You have got, we understand, a monopoly of the seedling raising business, but your monopoly provides a wide range of varieties. You ought to be able to provide every customer with suitable wares?—We are trying to do so. I am quite optimistic about it.

A.725. What you are anxious to secure is assistance in testing out these seedlings?—That is all.

A.726. Not in their production?—No.

A.727. In the work in which you are engaged are not many thick seedlings thrown out by chance, although you make crosses for thin seedlings?—Generally not.

A.728. Not many?—In fact none at all. I have such experience now for about 12 years and I have found none at all. If I want thick cane I have to choose a different class of parents.

A.729. It is surprising that with such a very large number of seedlings some of them should not have developed the thick character?—It is because none of the parents used were thick.

A.730. Your present limitations are really limitations of time? That is a most serious limitation?—Yes, chiefly time. Now we have got a fairly sufficient amount of land.

A.731. And the methods you are familiar with, at any time you could work upon a different series of types?—Yes.

A.732. At any time you could produce canes of almost any description?— That is what I think. I am very optimistic about it

A.733. It is all a question of time?—Yes.

A.734. You informed us that you were the only one trained officer. Would it not be advisable to have two. Something like a life-insurance?

A.735. Do you generally provide for two or three?—I have got at least four people who could do breeding all right.

A.736. That is my point. I understood that there was only one assistant who was doing breeding work?—No. The whole staff can do it.

A.737. *Dr. Hyder:* I want to know whether you have made any original contributions to the study of canes or cane breeding or you are simply carrying on the work in which you were initiated by Dr. Barber?—I have made material contributions on the breeding side of sugarcane and this has been duly recognised by the leading sugarcane journals of the world. In fact I could show you one or two cases where they have editorially reviewed my work with very great favour. Carrying on the work at the station is not like the carrying of a substance from one place to another. It is something like bringing up a growing child, problems develop as growth progresses. The child develops indigestion and kicks about and various devices have to be contrived by the person in whose charge it is. If I may say so, from the very beginning my contributions towards the breeding of sugarcanes have been material and my master Dr. Barber has himself handsomely acknowledged my work in some of his first publications.

A.738. Your works have appeared in print?—A number of them.

A.739. Have your canes been tried outside India?—Yes. There is one instance, which I quote, of a report from Cuba. My canes are now going almost everywhere. I am told that even Java has got them now.

A.740. Regarding the question of import duty, could you tell me what the real cost of production per maund is apart from the cost which is given in statements submitted to the legislature or to a committee?—I happen to know that in Bihar the cost of production per maund of cane, this is based strictly on information given to me, was in one instance hardly three annas, that is, the cost of production on the plantation. It compares very favourably with the cost of production in other countries of the world. It may be observed here, that, in the main cane tracts of India, the climatic conditions are such that we can grow cane very cheaply. In the United Provinces there is sometimes no need for irrigation. Bihar has such a rich, deep soil that we are able to get a very good crop indeed. It is my considered opinion that in India we should be able to produce cane at a much cheaper rate per maund than in the other sugar countries of the world.

A.741. So much for the people. What about the manufacturers and business men? They might perhaps have an import duty. You are of that opinion?—Yes.

A.742. *Sir Ganga Ram:* You use 120 inches of water. If your water were reduced would your yield be comparatively reduced?—I will just explain. This 120 inches of water was the average for the whole farm. But I have got varieties which could grow in 70, 50 and 40 inches. In fact I have got a cane in the Punjab which grows without any irrigation. It is a cane which has a deep rooting system and it produces sugar without irrigation.

(The witness withdrew)

The Commission then adjourned till 10 A.M. on Friday, the 19th November, 1926, at Madras. For evidence taken at Madras from 19th to 25th November, 1926, except that of Lt.-Col. R. McCarrison (Imperial) which follows, see Volume III.

Thursday, November 25th, 1926

MADRAS.

PRESENT:

The MARQUESS OF LINLITHGOW, D.L. (*Chairman*).

Sir HENRY STAVELEY LAWRENCE, K.C.S.I., I.C.S.
Sir THOMAS MIDDLETON, K.B.E., C.B.
Rai Bahadur Sir GANGA RAM, Kt., C.I.E., M.V.O.
Sir JAMES MACKENNA, Kt., C.I.E., I.C.S.
Mr. H. CALVERT, C.I.E., I.C.S.
Raja Sri KRISHNA CHANDRA GAJAPATI NARAYANA DEO of Parlakimedi.
Professor N. GANGULEE.
Dr. L. K. HYDER.
Mr. B. S. KAMAT.

Dewan Bahadur T. RAGHAVAYYA PANTULU GARU.
Rao Bahadur B. MUNISWAMI NAYUDU GARU. } (*Co-opted Members.*)

Mr. J. A. MADAN, I.C.S.
Mr. F. W. H. SMITH. } (*Joint Secretaries.*)

Lieut.-Colonel R. McCARRISON, C.I.E., M.D., D.Sc., LL.D., F.R.C.P., I.M.S. (in charge of the Deficiency Diseases Inquiry, Indian Research Fund Association, Pasteur Institute, Coonoor, S. India).

Memorandum on Malnutrition as a cause of physical inefficiency and ill-health among the masses in India.

The object of this memorandum is to indicate (*a*) the great importance of malnutrition as a cause of physical inefficiency and ill-health among the masses in India; (*b*) the intimate connection which exists between problems of nutrition and those of agriculture; and (*c*) the necessity for the closer co-ordination of nutritional, medical, veterinary and agricultural research in this country.

1. Of all the disabilities from which the masses in India suffer malnutrition is, perhaps, the chief. The more spectacular, endemic and epidemic diseases, such as cholera, malaria, dysentery, tuberculosis and leprosy, kill their thousands yearly; but malnutrition maims its millions, and is the means whereby the soil of the human body is made ready for the rank growth of the pathogenic agents of many of those diseases which afflict the Indian people. It has, for example, been shown by researches carried out under the auspices of the Indian Research Fund Association, that dysentery—a common scourge of India—can be produced under experimental conditions in animals, closely related to man, merely by feeding them on food deficient in certain substances (vitamins) upon which

normal metabolism is dependent. It was found that while well-fed animals might harbour the *entamoeba histolytica*, which is the cause of dysentery, they did not develop this malady although living in the same room and subject to the same risks of infection as ill-fed animals which, being carriers of this organism at the time the experiment commenced, developed dysentery in consequence of the lack of resistance to it brought about by the defective food. Similarly, it has been shown that hog-cholera and other infections can be caused to overrun the animal organism by the same means. These observations have now been confirmed and extended in other countries; and quite recently it has been found that the susceptibility to tuberculosis, typhoid fever and pneumonia—all of which are very prevalent in India—is greatly enhanced by the use of food of low biological value which contains an inadequate supply of vitamin A. Investigations of this kind have made it possible to enunciate the rule that many pathogenic agents of disease are capable of exercising their harmful effects only when the human or animal body is debilitated by various means of which imperfect nutrition is the chief. It follows, therefore, that a primary essential in the prevention of such diseases is the adequate nourishment of the human and animal organism. A number of other diseases of a metabolic nature are likewise the result of improper food. Of these it is only necessary to mention scurvy, rickets, beriberi, certain eye diseases and stone in the bladder, all of which exact an enormous toll in this country.

The effect of imperfect food in causing a degree of physical inefficiency, which may not be associated with any gross evidence of disease, is exemplified in India as in few other countries in the world. Few who have travelled far in India can have failed to observe the remarkable difference in physical efficiency of different Indian races; and although there are a number of factors, climatic and other, which play their part in determining these differences, yet it has been shown by researches carried out in this laboratory, and by Colonel McCay in Calcutta, that nutrition is the chief among them. The differences in physical efficiency of different races in India have been definitely correlated with differences in the biological value of foods which necessity, habit, or religious prejudice has forced them to use.

Malnutrition is thus the most far-reaching of the causes of disease in India. It is one of the greatest—if not *the* greatest—problems with which the investigator of disease is faced. It is, too, the chief among the problems facing those engaged in agricultural research. The ultimate aim of both is the same: the adequate nutrition of the people. So far, then, from agricultural and nutritional research being carried out in isolated compartments, there should be the closest co-operation between them, to the mutual advantage of each and to the widening of scientific vision.

2. It is not alone in regard to the human subject that malnutrition exerts such harmful effects. Man's domestic animals suffer no less than he himself. It suffices in this connection to refer to the effect on cattle of pasturage which is deficient in certain mineral ingredients. As an example of this kind the now well-known effect of deficiency of phosphorus in the soil, and, therefore, in the vegetation, on the health of cattle and sheep may be mentioned. Such deficiencies exist in large tracts throughout India as, for instance, in the soils of Bihar. In India, unfortunately, millions of stock exist in a state of semi-starvation. As draught animals they are consequently inefficient; and as producers of milk and milk products—so essential as food for mankind—they are more inefficient still.

There is, perhaps, no more important department of agricultural and nutritional research than that which deals with animal husbandry; and here I should like to emphasise that the problems of animal husbandry are also the problems of human husbandry.

3. Human and animal inefficiency is reflected in the soil; in its imperfect cultivation; in inadequate manuring; and in crops scanty as to quantity and deficient as to quality. Too few animals are kept by the cultivator, as the scanty vegetation cannot support them; and so there is

returned to the land too little of that organic matter, in the form of farm-yard manure, on which the continued fertility of the soil is so dependent. It has been shown in regard to plants, as in regard to animals, that they cannot thrive, nor their seed attain to the fullest "reproductive quality", unless they be provided, in addition to the mineral constituents of their food, with certain organic substances known as "auximones". These substances, which are akin to vitamins, are as essential to the normal metabolism of plants as vitamins are to the normal metabolism of man and animals. They not only enable the plant to build up from the simple ingredients derived from the soil those organic complexes required as food by men and animals, but they enable it to elaborate vitamins without which these organic complexes cannot be properly utilised by the animal organism. Auximones are produced in the soil from decaying organic matter by the action of certain soil bacteria; and the best organic matter for this purpose is farm-yard manure. So it is that such disabilities of mankind as are due to faulty nutrition are sometimes traceable to the soil itself, which has become exhausted and unproductive of the best kind of food through improper attention and cultivation. Malnutrition, thus, pursues its harmful course in an ever-widening vicious circle; the cultivator is too often ill-nourished and ravaged by disease which is commonly the result of his ill-nourishment; his beasts are alike ill-nourished; while both toil wearily in a heartless effort to extract from the ill-nourished earth enough to keep them from starvation. The solution of the problem of malnutrition is thus, to a great extent, one of improvement in methods of agriculture.

4. Considerations of this kind led me, in the course of the inquiry on which I am engaged, to attempt, in a way as wide as my limited circumstances permitted, a study of the soil conditions which influence the nutritive value of the commoner food grains of India. Millions of people in this country rely from generation to generation on a single cereal as the main staple of their dietary. It seemed necessary, therefore, to be aware not only of those soil conditions which influence the yield of grains but of those which influence their nutritional quality. This attempt was made not only because it was the logical outcome of the work on which I was engaged —an inquiry into the effect of faulty food on the causation of disease in general—but also with the object of widening the scope of nutritional investigations and of linking them up with agricultural research to which they are so closely allied. The soil conditions which it was thought would be likely to influence the nutritive quality of food grains were (*a*) the chemical composition of the soil itself; (*b*) the manurial treatment to which it is subjected; and (*c*) irrigation as compared with normal rainfall. So far my investigations have not proceeded beyond the experimental study of the effect of certain manures on the nutritive value of millet and wheat. They are, unfortunately, very tedious and the output of work is limited by the limitations of a single investigator. The results already arrived at are, however, of interest. It has been found in regard to millet—a common food grain in South India—that soil on which it is repeatedly grown, but which has received no manure for many years, yields a grain the nutritive value of which is so low that it may actually be harmful to the users of it; suggesting the acquirement by the grain of toxic qualities. It has been shown, moreover, that the nutritive and vitamin values of the millet grown on soil treated with cattle or farm-yard manure are markedly superior to those of millet grown on the same soil when treated with a complete chemical manure. In regard to wheat it has been found that when it is grown on soil treated with farm-yard manure, its nutritive value is approximately 17 per cent. higher than when grown on soil treated with complete chemical manure. The deficiencies of the wheat grown under the latter conditions are due in the main to an inferior content of vitamin A, that substance which is so essential in maintaining the resistance of man and his domestic animals to infectious diseases. In this work—which I venture to think provides an example of the advantages to be derived from collaboration between investigators of nutritional and agricultural problems—I have had the active assistance of the Department of Agriculture, Government of

Madras, and of the Agricultural Chemists on the staff of the Agricultural College, Coimbatore, without which it would have been impossible to carry it out.

5. Questions of irrigation—the means to be adopted to prevent the slow but sure deterioration of soil which is constantly being irrigated, and the consequent deterioration of the crops grown upon it—are alike of interest to students of nutrition and public health and to those engaged in agricultural research. The possible bearing of these questions on the tendency towards intense malaria when dry crops are grown under canal irrigation is one of the most important of the public health problems awaiting solution. It has been referred to in detail in Mr. Albert Howard's Presidential Address before the Indian Science Congress at Bombay early in the present year: an address which brought into prominence certain aspects of agriculture and their relation to disease which are of the utmost importance to this country.

6. Among the manifold needs of India at the present time not the least urgent are these:—

(*a*) The wise extension of research on nutrition—plant nutrition, animal nutrition and human nutrition—under broad-minded direction. These are not different subjects but the same subject: a continued story following a natural and ordered sequence from its beginning with the soil, through vegetable and animal life, to its final stage in the man himself. In the telling of this story India should be encouraged to play an adequate part. My experience of Indian assistants has taught me that nutritional research is of a kind which appeals to the Indian possessed of the necessary scientific education. For my own part, I would desire to see many such young Indians trained in its prosecution and engaged upon it under proper direction.

(*b*) A second need is the co-ordination of all the forms of research—nutritional, medical, veterinary and agricultural—which have for their aim the betterment of the health and physical efficiency of the people of India. It is essential that those who are engaged in agricultural research should be aware of its bearings on public health or *vice versa*. At the present time much effort is dissipated for want of such co-operation between research workers. The matter is, however, beset with many difficulties. I mention it merely to indicate its importance.

It is, I believe, only by the extension of research along broad lines, by its proper co-ordination, and by the employment of the best brains which India can herself provide, that this country will obtain the highest return for money expended upon research.

Oral Evidence.

A.743. *The Chairman:* Colonel McCarrison, you are a Member of the Indian Medical Service and you are in charge of the Deficiency Diseases Inquiry, which is under the Indian Research Fund Association, at the Pasteur Institute, Coonoor?—Yes.

A.744. Sometime ago you provided the Commission with a note giving an outline of the work on which you are engaged; since then my colleagues and I have had an opportunity of visiting your Institute at Coonoor, of seeing your work and of having the advantage of an explanation by yourself of what you are doing there; but we were anxious to get some facts connected with your work and some of your views and so we have asked you to come here to-day. I understand from what you have already told us that it is your view that the Institute over which you preside at Coonoor, the Agricultural Research Station at Coimbatore and the Animal Nutrition Section at Bangalore, from the fact of their relative contiguity, offer a great opportunity for the extension of your work in this Presidency?—That is my opinion. One point is that I am not in charge of the Pasteur Institute at Coonoor; I am a guest there; I have my laboratories there. But I feel that Madras is very fortunately situated for research work on nutrition in all its branches, human, animal and vegetable, because of the nearness of Coonoor, Coimbatore and Bangalore to each other.

A.745. I take it that it is your view that the general problems of malnutrition in man and beast bear very closely on the terms of reference of this Commission?—Yes, I think so.

A.746. I shall ask you to describe some of your work in a moment or two; what other work of this nature is being carried out in India at this moment?—As far as I am aware there is no work being carried out in India on nutrition at the present time except what I am doing.

A.747. So that, so far as nutrition in man goes, you are the only officer engaged on research on an absolutely vital problem affecting the welfare of 300 million people?—Yes.

A.748. Are you carrying on the work as a successor of someone else, or did you create this work yourself?—I created it.

A.749. Have you any successor in view?—I know of none.

A.750. If you went to-morrow, would your work be carried on?—There would be no one, so far as I am aware, who could carry on, who has devoted his life to the study of nutrition as I have done.

A.751. How many years have you been engaged in this work?—My work in connection with nutrition itself I started in 1913, just before the War; it was interrupted by three years' active service; then I came back to it again; it was interrupted again owing to financial retrenchment and it has been finally re-established 15 or 16 months ago. Every time I have gone the work has come to an end and has had to be started afresh, even to the making of my animal cages and so on. Right from bed-rock I have had to start afresh every time. Personally I think that is a great pity. I feel that this work on nutrition is of such vital importance to the people of this country that it ought to be put on a permanent basis.

A.752. What basis do you suggest?—I suggest that there ought to be established at once or as soon as possible an institute of nutrition which would deal with problems of nutrition in human beings, animals and plants, because nutrition is not a matter which refers only to the human being; nutrition refers to men, animals and plants.

A.753. Would you suggest that such an institute should be under the Government of India or under the Government of some Presidency or Province?—There is room for such an institute in every Presidency in this country. There is room for another one under the Government of India. My experience is limited to this Presidency, and as I said, this Presidency is particularly suited for the work.

A.754. I suppose your own feelings are that you are not very much concerned how continuity is attained provided it is attained?—That is so. My business is to do the work; it is the business of others to see it is continued.

A.755. You have no firm views as to whether your own particular institute, if it could be connected up with Coimbatore so far as plant nutrition goes and with Bangalore for animal nutrition, should be under the Provincial Government or the Government of India?—No, I am not concerned with that.

A.756. Have you sufficient space at Coonoor to extend?—No, I have not. I have got three laboratories there; that is all that is available there at the moment for work in connection with nutrition.

A.757. Have you the land upon which further buildings could be erected?—There is a good deal of land, I understand, connected with the Pasteur Institute at Coonoor, if it is decided to make that a centre of nutrition work, where buildings could be erected if they were necessary.

A.758. Is it your view that Coonoor is an appropriate place in which to carry on this work?—I think it is an ideal place.

A.759. Are there any buildings in the immediate neighbourhood of the building at present occupied by your animals and so forth, which might usefully be leased or bought?—There is a vacant jam factory which is next to the Pasteur Institute; the grounds of the two institutions are side by side; the buildings are eminently suited for nutritional work, but I understand it is the intention to apply them to some other purpose, with the details of which I am not familiar.

A.760. Official or non-official?—I only know this unofficially.

A.761. The use of the buildings is to be non-official?—No; official.

A.762. Now I think I may leave you to give the Commission an outline of your work; I think it must be an outline only, because plainly we are not as a body concerned with the detailed scientific aspect of the work which you are doing at Coonoor, and I hope you will bring out if possible the direction in which man and beast inhabiting these areas are suffering from malnutrition, and if possible indicate to the Commission the sort of direction in which within the economic capacity of the individuals who are suffering from malnutrition some steps to remedy the situation might be adopted?—By "malnutrition" I mean the impairment of the normal physiological processes of the body consequent on the use of a food which is deficient in quality although it may be abundant in quantity. The remarks which I have to make do not therefore deal with the problem of starvation or of semi-starvation which I recognise as being also an important cause of malnutrition; I am dealing solely with the quality of the foods in common use in this country and with their capacity thoroughly to satisfy the functions of food. The functions of food are four-fold,

(1) to repair tissue waste,
(2) to supply energy,
(3) to maintain the normal medium in which the bio-chemical processes of the body can take place, and finally,
(4) to make these processes possible.

My work has been chiefly concerned with the last of these, that is to say, with vitamins: substances the function of which may be compared to that of the spark which ignites the fuel mixture of a petrol engine liberating its energy. The spark is of no use without the fuel, nor the fuel without the spark. I would like now to show you what are the effects on animals which receive an adequate diet consisting of proteins, fats, carbo-hydrates, salts and water in proper proportions but which is lifeless owing to the want of these substances, vitamins. This chart (marked "A")* shows that if rats be fed on a diet containing everything they require, proteins, fats, carbohydrates and salts, but without vitamins, they will not grow and after a very short time they become paralysed. These are paralysed rats which have

* Figures and Charts follow after page 116. Chart "A" has not been reproduced.

been fed on an otherwise adequate food which contained no vitamins. The same results follow in pigeons, men, monkeys and other animals. One of the chief foods in use in India and in this Presidency especially is rice. I should like to show you that rice is a fundamentally poor diet; it is a diet which in itself will not support the human body in its fullest efficiency, although the people who are using rice may be eating it in large quantity. In this chart (marked " B ") the lower curve relates to a group of animals which have been fed on an otherwise complete diet containing no vitamins. To this diet I added one gram of rice so as to provide the necessary spark, the vitamins. The next curve indicates the rate of growth under those conditions. If instead of adding one gram of rice I add one gram of wheat the difference is enormous. Rice is therefore a fundamentally poor diet. I next tried to ascertain why it is that rice is so poor; so I added vitamin A to it. The next curve indicates the rate of growth. I then added vitamin B, and the next curve shows the rate of growth. Yet I was unable to make it equal to that given by one gram of wheat, the reason being that rice contains a protein of poor biological value and is also very deficient in certain substances such as manganese which is very important for growth. Here is the chart (marked " C ") of which I have shown the original photograph. If now I take a diet which is complete in every regard, proteins, fats, carbo-hydrates, salts and vitamins, and add to it a slight trace of manganese, as much manganese as there is in wheat, wheat being particularly rich in it, you will see I make good to a great extent the deficiency of rice; that is to say, I have got to add vitamins A and B and manganese before I make rice equal to wheat in nutritional value. This is exemplified in another way; here is a chart (marked " D ") which represents the difference in nutritional values of certain grains in common use in India. This one is wheat; these curves represent *cholam* and *cumbu*, two grains in common use in this Presidency, this one represents paddy. The two rats at the bottom represent the difference between a wheat rat and a paddy rat. When the Commission did me the honour of visiting my laboratory, they saw there an experiment dealing with the relative values of the national diets of India tested biologically on groups of animals of the same original weight. These diets are representative of different peoples, Sikhs, Mahrattas, Pathans, Gurkhas, Kanarese, Bengalese and Madrasis. You will see on this chart (marked " E ") that the diet of the wheat-eating people of the north who also take a great deal of milk, butter and *ghi*, far surpasses in value that of the rice-eating people of the south. The upper chart shows the distribution of leprosy in this country. You will notice that the greatest prevalence of leprosy is amongst the people who use the poorest food while the least prevalence of leprosy is amongst the people who use the best food.

I have chosen leprosy to represent and emphasise this particular point, but it is not only with regard to leprosy that this is true; it is true with regard to other diseases. For example, the death-rate from cholera in Madras is 40 times greater than it is in the Punjab. Chief amongst the diseases which these deficiencies in diet cause are diseases of the gastro-intestinal tract. I see from the report of the Surgeon-General with the Government of Madras for last year that there were no less than 9,500,000 attendances at the hospitals and dispensaries of this Presidency. In the course of my work, I have produced in animals acute gastro-intestinal diseases like diarrhœa, dysentery and so on, and chronic gastro-intestinal diseases like dyspepsia, dilatation of the stomach and colitis. Of these 9,500,000 attendances at the hospitals and dispensaries of this Presidency, I calculate that no less than 3 millions are ill-nourished, and are suffering from diseases which are directly or indirectly due to malnutrition. In this chart (marked " F ")* you will see what the effect of a perfectly good diet is on the gastro-intestinal tract of a monkey when that diet has been killed by auto-claving in a temperature of 130° C. for an hour and a half, which has had the effect of destroying the vitamins. This is the gastro-intestinal tract of a healthy monkey which was living in the jungles of Madras 3 or 4 days before I put it under experiment. The lower chart shows what the effects of the devitaminised diet are.

* Not reproduced.

There is great dilatation of the stomach, the colon is converted into an inert bag, causing chronic constipation and all the evils which result therefrom. It is not only with regard to food deficiencies that this work of mine deals, but also with regard to diseases arising from poisons contained in the food grains. You will see here a picture (marked "G")* of three: a man and two boys. The man is of magnificent physique, from Hunza, where lives probably one of the finest races of mankind. He and many others were transferred in my time as Agency Surgeon at Gilgit to a new tract of land, where the wheat grown was of very poor quality and therefore they had to grow a vetch called *lathyrus sativus* with the result that they suffered from Lathyrism, which causes a kind of paralysis, and has paralysed these subjects from waist downwards. Nutritional work does not deal only with deficiencies in food. Here is another chart (marked "H"), which illustrates the difference between a Sikh diet, illustrated by the upper curve, and a diet which is in common use among the poorer Europeans, both in this country and at Home. I took two groups of animals of the same initial weight and one of them I put on a diet consisting of milk, green vegetables, butter, fruits, whole wheat bread and occasionally meat; you will see that they did very well, whereas the animals that were fed on the poorer European diet did very badly. That diet consisted of white flour (white bread), tea, sugar, margarine, jam, potted meat and boiled vegetables. The potted meat and margarine contained such preservatives which are now in common use, namely boracic acid, sulphurous acid and formal-dehyde. I wish to emphasise that the second group of animals died from two causes, gastro-intestinal diseases and lung diseases. Lung diseases are among the most common diseases in this country. You will see in this chart what you might call for the purposes of explanation the Sikh rat and the poor European rat. Not only does the poor European diet give rise to these conditions, but it also produces new growths in the stomach, which I am investigating at the moment, and which may be, although I am not prepared to say so at present, the beginnings of cancer. You can see what the appearances of the two groups are in this picture.

The next picture to which I would like to refer shows the effect of white flour, which is nowadays being so commonly used not only outside this country but also in this country. These animals were fed on the usual diet which contains everything except vitamins. One group was given 1 gramme of white flour, the other 1 gramme of whole wheat flour (*atta*) to supply the vitamins. You will see that the former did not grow, whereas the rats which were given 1 gramme of whole wheat did grow, but in the former case immediately I added the vitamin, they grew so quickly that they overlook the others. I show here one of the animals that were getting the wheat, one of the animals that were getting white flour, and a paralysed animal that was getting the basal diet only. At this point I added vitamins and you see from the chart (marked "H2") how rapid the growth was. In connection with the susceptibility of mankind, when they are so fed, to disease, I should like to emphasise in this chart that men living at this level have but a short race to run before death overtakes them, if they be infected by something like cholera or dysentery, whereas if better fed, they have a much better chance of escaping death. The next illustration (marked "I")* contains life-size pictures of stone in the bladder, which I have produced in animals by feeding them on a faulty diet. I wish to remark that this is one of the diseases in this country which is so prevalent and which causes an immense amount of distress; I have succeeded in producing it in animals, and therefore I hope to succeed in doing away with it in man if people are only able to feed themselves properly. I have already drawn your attention to the fundamental poverty of rice as a food. In addition to this poverty of the grain as it comes from the field, it is subjected to all sorts of milling and polishing processes. This chart (marked "J1") represents groups of animals fed on the same rice which was specially grown for me by the Agricultural Department of the Government of Madras; and which has been subjected to the various milling processes. The first curve shows the effect of a diet of the original paddy; it does no more than just support the animal at main-

* Not reproduced.

tenance level. When the rice is par-boiled, it just fails to support them at maintenance level. In connection with this failure to support them at maintenance level, it fails to keep them in health; one of the chief complaints from which they suffer is eye disease. In this Presidency alone there were no less than 885,000 people attendances at the hospitals and dispensaries for eye diseases; that is to say 1 in every 50 of the whole population.

A.763. *Professor Gangulee:* That is due to the deficiency of vitamin A?—A great part of it is due to the deficiency of vitamin A. When you proceed to polish the rice, you greatly reduce its food value, until you get the highly polished rice which is so widely in use, and is quite incapable of supporting life; and unless it is supplemented by other articles of diet, health cannot be maintained.

A.764. *Sir Ganga Ram:* Polished rice is rather a luxury for European countries, is it not?—Yes, it is, but I do not think European countries are as yet very much wiser with regard to food than we in the East. This chart will illustrate to you how the disease of beriberi occurs in this Presidency. Beriberi is a disease which is peculiarly the property of the Madras Presidency; it occurs on the East Coast of Madras, and practically nowhere else in India. You see in this chart (marked " J2 ") the food value of rice subjected to high polishing. No man lives by rice alone; he has to take gram or *dal* or something of the kind; in this Presidency the people usually take something like 2 to 4 ounces of *dal*.

A.765. *Dr. Hyder:* What kind of *dal*?—I am not sure, but I think it is *tur dal*. Animals fed on a diet which has the nutritive value of the highly polished rice will not develop beriberi. Beriberi is due to the insufficiency in the diet of a substance called vitamin B; it is only when the insufficiency reaches a particular point that beriberi occurs. Paradoxical as it may seem, a little vitamin B is necessary for the production of beriberi.

A.766. *The Chairman:* Otherwise the man dies of starvation before he gets beriberi?—Yes, he dies of a specific form of starvation. This is a chart (marked " L ") which illustrates the relative values of various rices in use in India; they vary tremendously. Here is another chart (marked " M ")* which introduces another phase of the subject, that is to say deficiency of certain mineral elements. Deficiency of iodine is an important cause of a certain form of goitre and of its sequelæ, namely, cretinism and hairless disease which is common in certain animals, for instance, hogs and goats. I do not know whether hairless disease occurs in India or not. I have been able to produce cretinism and hairless disease experimentally in animals. In the middle chart, we have an example of another influence of vitamin deficiencies, that is to say, great susceptibility of both man and beast to infection in consequence of those deficiencies. In this particular instance the disease produced was Epithelioma Contagiosum, which is a disease that affects fowls and other birds. As I see the Commission is desirous of ascertaining the extent to which the keeping of fowls could be introduced in this country, I would like to point out that one of the diseases from which they are liable to suffer is Epithelioma Contagiosum and they will suffer from it unless they are properly fed. Here is a chart (marked " N ") which illustrates the complete eradication of goitre from a school in consequence of the researches that have been carried out in my laboratory. The next chart (marked " O ")* shows the effects on the gastro-intestinal tract of faulty food deficient in vitamins. The cross-section of the large bowel is shown here, and you will also see a representation of the normal large bowel, which is provided with a very intricate neuro-muscular mechanism. The specific effect of deficiency of vitamin B is to interfere with this mechanism so that the gut becomes converted into an inert bag which cannot empty itself and becomes subject to disease in consequence. In this chart you will be able to see the differences between the healthy and the diseased colon. Great atrophy has taken in the latter place.

A.767. *Sir Ganga Ram:* Has food anything to do with the increase of tuberculosis?—Dr. Muthu of this Presidency is the great authority on tuber-

* Not reproduced.

culosis in India, and he is convinced, after having spent a lifetime working on it, that a contributory cause of tuberculosis in this and other Presidencies in India is malnutrition.

A.768. Is impure air a factor?—This factor comes in; I do not wish to be understood to say that food is the cause of every disease, but faulty food deficient in the vitamins is the foundation on which many diseases are built. Its chief effect is to cause depreciation of cellular function throughout the body; and depreciation of cellular function makes it possible for pathogenic organisms to grow in the body; no pathogenic organism will flourish on healthy vigorous tissue. I want to emphasise strongly that there is no single factor so important to the well-being of any people as a well-balanced, nutritious diet.

I now refer to the chart marked "P." As an outcome of this work, we must, of necessity, come back to the soil. So, in the course of these investigations, I found, for example, that rice grown on the East Coast of Madras and the same rice grown on the West Coast of Madras differed in nutritive quality. I then tried to find out what the cause of that was. I thought it might be due to differences in the soil and one of the first things we investigated in collaboration with the Agricultural Department of this Presidency was the effect of manurial conditions on the nutritive value of wheat. I will give you an example. On this chart one curve represents our basal diet containing no vitamins; the next curve represents the basal diet containing vitamin A; the next curve represents the basal diet containing all vitamins; and the last two curves represent the basal diet *plus* one gramme of wheat which has been grown on soil manured with cattle or chemical manure. One gramme of wheat grown on soil manured with cattle manure gave a rate of growth which is approximately 17 per cent better than that of wheat grown on the same soil with artificial mineral manures. But the point I should like to stress here is this: that whole wheat, however poor it may be, is a magnificent food; it is better than cod-liver oil and marmite put together. Before I leave this subject, I should say that subsequent experiment revealed that the reason why cattle manure wheat is better than chemical manure wheat is because of a deficiency of vitamins in the latter. This chart (marked "Q") relates to experiments of a similar kind with millet. But the experiments were of a different order. I took first of all a diet of polished rice such as that dealt with on a previous chart. I fed groups of pigeons on this polished rice. Then by adding millets from various sources, I saw to what extent these millets were capable of preventing the animals declining in weight. Here again we find that millet grown on cattle manured soil has a greater capacity for preventing loss of weight than that grown on chemical manured soil. The curious thing in this experiment was that millet grown on soil which had received no manure at all for a long time was actually harmful. The last piece of work which I have been attempting to do, and which is as yet incomplete, I show you mainly to illustrate the extraordinary width of range that this work on nutrition has. This chart (marked "R") illustrates the results so far of an enquiry into the effect of various kinds of irrigation on the nutritive value of wheat. At present the experiments are incomplete, but there is one point to which I might refer. It has been suggested that continued old canal irrigation reduces the nutritive value of wheat. This experiment has been going on for 75 days and there is no proof that old canal irrigation does influence the nutritive quality of wheat; but the experiments are incomplete and I am not yet prepared to give an opinion with regard to it. That is a very brief outline of the kind of work we are doing at Coonoor.

A.769. *Professor Gangulee:* What about paddy? The irrigation in this Presidency is mostly on paddy?—That I do not know yet; this work has only just begun.

A.770. *The Chairman:* Colonel McCarrison, we are greatly obliged to you for the very interesting account of your work which you have given us. I think we must resist the temptation to pursue you into the thickets of physiological disputation, but I think my colleagues would like to ask you

one or two questions based on our terms of reference?—If I may say so, when you did the honour of visiting me at Coonoor, you also asked me whether I would also say something to the Commission on the effect of malnutrition on animals. I am perfectly prepared to do so, should you wish it.

A.771. I think we should like to hear that now?—I can do that very quickly. In these observations I am now going to make, I am not dealing with the effects of an insufficiency of food on cattle; I am dealing solely with the effects of a faulty food, a food which is in itself incapable of fulfilling the functions of food, on animals which do not receive, for example, a sufficiency of minerals in the food. So far, research on stock has been carried out mainly from the point of view of deficiency of mineral elements, while research on man has been mainly carried out from the point of view of deficiency of vitamins. It is a most excellent thing that it should be so, because the result has been that one branch of nutritional research has gone along one path while another branch has gone along another path; and those two paths must eventually meet; it is absolutely necessary that they should converge and go along the same road. Therefore, there is very much that those engaged in nutrition research on animal nutrition can learn from us and very much that we can learn from them. The chief effects on animals so far studied are those due to deficiency of certain mineral constituents in natural pasturage. Animals become poor, small sized, and low milk-yielding in the case of cattle. I showed in the year 1918 that the milk which the cattle produce and the butter which we get from the milk are, in consequence of the poverty and dryness of the fodder, lacking in one of the vitamins, vitamin A. The general effects of deficiency disease in stock animals so far elicited are these: A slow rate of growth in young animals which is due chiefly to a deficiency of calcium and phosphorus. I understand that there are these deficiencies in the soils of Bihar and the West Coast of Malabar, though I know of very little work that has been done on this subject in India. Secondly, the animals are slow to attain maturity. Thirdly, there is a marked tendency for stock to decrease in size; the stock tends to remain at a size which is proportionate to the food available, just as has happened with regard to children in Russia. Fourthly, there is a high mortality, which is due no doubt to increased susceptibility to infection. Fifthly, the milk-yield is low in cows and the quality, that is to say, its vitamin value, is also low. The birth-rate tends to be low; sterility is fairly high. The carrying capacity of cows is reduced, they have poor coats, and they suffer from skin diseases. There is an abnormal craving (*pica*, as it is called) for various things such as bones, a condition which is known as osteophagia. They also eat earth, mud and very often in this country they eat things that are worse than mud. They have a great craving for salt and salt licks. I am not sure whether it is so, but I am told that some of the goat herdsmen in certain parts of India actually take their herds in the morning round the village to play the part of scavengers. I would now like to refer to the effects of specific deficiencies. One of the first of these is want of iron. That gives rise in pigs to a disease which is called McGowan's disease. It is not necessary to go into the symtomology of this disease. Deficiency of iron also causes great emaciation and anæmia, a condition which is common in certain parts of New Zealand. Then, want of iodine also, as I have said, gives rise to goitre and hairless disease, examples of which I have shown you as having been produced in my laboratory. Want of iodine also impairs the capacity of the animal to assimilate calcium and phosphorus, and so the bones become soft. Want of phosphorus in the soil leads to osteomalacia, which is softening of the bones, poor bones, fragile bones, swelling of joints, stiffness of hind quarters and lameness, a condition which in South Africa is called *Styfsiekte*. Want of phosphorus also causes craving for bones. This craving for bones leads the animals to look for bones in decaying carcasses. In these decaying carcasses they find an organism which produces a very virulent toxin which gives rise to a disease known in South Africa as *Lamziekte*. That disease is due to the products of the bacteria which live in the decaying bones; the

bacterial toxins are the actual cause of the disease. It is the want of phosphorus that causes the animals to eat these bones. Another cause of disease in cattle is want of salt, chlorine and carbonates. This is a summary of most of what is known at the present time as to the effects of malnutrition in the causation of disease in animals; no doubt there is much more to be discovered if we look for it.

A.772. *Sir Ganga Ram:* What disease would you expect to arise merely from want of salt?—I should expect emaciation and slowness of growth.

A.773. In milk animals does it decrease the quantity of milk?—Now you are asking me of matters of which I have no personal experience, but from the knowledge I have of experimental work I should say it would lower the capacity of the animal to produce milk. In addition to these diseases, there are others which are the result of infection by micro-organisms consequent upon a state of malnutrition. One of these is called Sarcospiridia or scrapie in sheep. Another condition which is common in sheep and goats is pernicious anæmia, a condition which I have succeeded in producing in the laboratory. Finally, there is the condition, which I have also produced, of hog cholera. These are some of the diseases which are known to prevail in other countries consequent on malnutrition; that is to say, consequent on the consumption of a food which is of poor quality. I do not know to what extent they prevail in this country, but I have given you the list so as to emphasise the very great importance of research on animal nutrition. It is necessary to ascertain to what extent these diseases do prevail in this country.

A.774. *Sir Henry Lawrence:* Is nutrition work on similar lines being conducted in institutions in Europe?—Yes, very largely.

A.775. Where?—Well, of course Cambridge is the centre of it. Sir Gowland Hopkins is the father of modern nutrition, and his work is being carried on there with great vigour. It is also being done at the Rowett Institute in Aberdeen and at the Lister Institute in London. No doubt there are other places which escape my memory at the moment. There are at least four or five centres of nutritional work in England alone where the population is something like one-sixth of what it is in India.

A.776. *Sir Ganga Ram:* What are the journals or pamphlets in which they publish the results of their labours?—All the work done on behalf of the Indian Research Fund Association is published in the official journal of the Indian Research Fund Association.

A.777. *Mr. Kamat:* Are not the Japanese also doing this kind of research?—Yes, they are.

A.778. *Sir Henry Lawrence:* And in the United States?—Very much.

A.779. The Rockefeller Institute has taken it up?—The Rockefeller Institute has not done so much as McCollum at the Johns Hopkins Institute. When I was in America I was greatly impressed by the work that was being done, especially at the Johns Hopkins Institute. McCollum is of course one of the chief names in connection with this work; his book on the subject is one of the standard works.

A.780. And in regard to nutrition work on animals are there similar institutions? There is one just being started in Edinburgh, I think?—Yes; and there is one which has been going in Aberdeen for some years, which has been doing good work.

A.781. Do they carry on experiments on rats and other animals?—Most of the work on human nutrition is done on rats because the rat is an omnivorous animal, and the life of the rat being short one is able to study it from the day of its birth to the day of its death, a comparatively short period of time. If we had to use larger animals, such as monkeys, it would be impossible to get the work done in a reasonable time. All that has been found but with regard to rats has been shown to be applicable to man.

A.782. It has been established that the results obtained from rats are applicable to man?—Yes. For instance, the work on rickets has been done

on rats and dogs, and it has been directly applied to the great benefit of humanity.

A.783. In the greater part of India, is there a sufficiency of milk in the diet?—I wish to be very guarded in any answer I should give you, because my experience is mainly a laboratory one; but from what I know, I should say that there is not nearly enough milk in the diet of the people except in that of some of the better class people in the north of India. There is certainly not nearly enough milk and milk products in the diet of the Southern people.

A.784. The superior physique of certain races in the north may be connected with their having a larger provision of milk in their diet?—It is connected with it, that is my opinion. I should say it is due to the combination of whole wheat, milk and milk products.

A.785. You attach a considerable value to the item of milk?—Very great importance.

A.786. Therefore it follows that one of the greatest problems of India is to secure sufficient provision of milk in those Provinces where it is now deficient?—That is so.

A.787. You attach great importance to that?—Very great importance.

A.788. You have mentioned the case of goats being fed in the surroundings of villages. Cattle also eat excreta?—Yes, I have seen them do it.

A.789. Does that have a deleterious effect on their milk?—That I do not know from personal experience, but I should imagine it would.

A.790. It would be possible to ascertain that?—Of course, anything is possible of that sort, provided we have the means to do it, the laboratory facilities and the staff.

A.791. It would not be without a certain value, for I have known a town which depended for its sanitation on the cattle eating excreta, and it was definitely put forward by the municipal council as being the best form of sanitation that they could think of. You would not agree with that?—It is certainly one way of carrying on conservancy work, but what the effect would be on the cattle would be a very interesting thing to find out, because if they were at the same time deficiently fed they must suffer from all sorts of infections, infecting themselves from the excreta.

A.792. And that infection may be passed on to the milk?—Certainly, it might quite well be so.

A.793. It might be a very important subject for investigation?—It might, yes.

A.794. Amongst the results of malnutrition can you trace sterility?—It has been so traced in other countries and as a matter of fact the first reference to it emanated from my own laboratory. In feeding animals in this way on diets extremely deficient in vitamin B, I noticed in 1918 that atrophy of the testes was one of the earliest effects. During famines and war, sterility in women and failure of the menstrual function have been recorded as evidence of malnutrition. Which of course was half-starvation also.

A.795. From that it would follow that any section of the population who suffer from half-starvation would be deficient in reproduction?—Not necessarily so, because it depends upon the respect in which their food is deficient. For example, in order to produce that effect their diet must be deficient in a vitamin which is now being called vitamin E. Vitamin E is quite abundant in such things as wheat, paddy and other cereal grains and in green leaves, meat and fats; in fact it is in cereal grains that it is chiefly found; so that I would expect to find sterility more common in people who are subsisting, say, on white bread, than I would in people who are subsisting on a home provided paddy diet.

796. *Dr. Hyder:* Taking the case of Eskimos, I would imagine that they would not eat much cereals?—No.

A.797. And I think with them there probably is a diminution of this power?—That race is said to be dying out to a considerable extent; but there

are many causes. One of them is infectious diseases, tuberculosis and so on. But all these vitamins are so widely distributed in nature and in flesh foods that Eskimos who would be eating blubber would probably get plenty of them.

A.798. That would be fat?—Yes.

A.799. Do you think vitamin E would be present in blubber?—I should think it would, but I have never investigated that substance.

A.800. The Eskimos live in a part of the world which is not very populous?—Their food of course is very limited in choice.

A.801. *Sir Henry Lawrence:* We were just discussing the malnutrition which appears to exist in the paddy diet. In that diet there is vitamin E?—Yes.

A.802. So you may possibly find a combination of an excessive power of generation with a serious condition of starvation?—I could not answer the question; I have not got enough information.

A.803. It might possibly result?—I should hardly say excess of power of reproducing the race; but I should say, more properly perhaps, very little impaired capacity to reproduce the race might exist with certain forms of malnutrition.

A.804. But we are finding at the present time, are we not, that there is an excessive power of generation among the C.3 population?—Apparently that is so, but I myself have not studied the subject.

A.805. Is it possible that any particular kind of diet may lead to sterility?—Yes, that is quite possible. Diets which are deficient in vitamin E, for example, will certainly lead to sterility.

A.806. It can be induced?—It can be induced in the laboratory; I can induce it myself at will; sometimes I find that my rats reproduce more quickly than I can deal with them; what I do then is simply to reduce the amount of milk and butter which they are getting and they stop breeding, or at least they do not breed so fast.

A.807. *Sir Ganga Ram:* Has the nature of food anything to do with the disparity of male and female births?—I do not know.

A.808. Have you ever studied that?—No.

A.809. The disparity is so great in different Provinces?—Yes.

A.810. In the Punjab, for instance, the percentage of male population is much more than that of female population?—I can quite see that you would be very interested in extending the study of nutrition in this country. At this meeting I am receiving many suggestions from the various Commissioners which emphasise the great importance they attach to the extension of this work.

A.811. You say there is want of calcium and phosphorus in the diet of cattle. Would gypsum be of any use?—I should have to refer you to the veterinary people for that sort of information. I have just made a summary of the diseases from which cattle suffer for your information.

A.812. Does manganese exist in any other cereal which can be eaten with rice?—Yes, it is very widely distributed in nature. If you are interested in it I can tell you where it occurs: it occurs in cabbage leaves, turnip leaves, asparagus tops, leeks, garlic, onion; fruits: orange, lemon, strawberry, while whole wheat is particularly rich in it. Wheat bran contains as much as 3·9 milligrammes per 100 grammes. Estimations in my laboratory have shown whole wheat to contain 4·82 milligrammes per 100 grammes. It also occurs in animal tissues, especially in the organs of chief functional capacity like the liver, pancreas, lymph nodes, kidney, muscles of the heart, brain and lungs. In connection with its occurrence in the pancreas, it may interest you to know that it also occurs in the active principle of the pancreas, insulin. Diabetes is an extremely common disease in this country and it is quite possible that the further study of the relation of manganese to the functional perfection of the pancreas may throw great light on the subject of diabetes.

A.813. Can deficiency of iodine be made up by any specific vegetable?—Yes, it can be made up. It is a curious thing about these substances which exist in very small amount in foods (vitamins, manganese and iodine) that they are all found to have more or less the same distribution in plants, so that if a man eats plenty of green leafy vegetables and whole wheat, he is not likely to suffer from iodine or other deficiency.

A.814. When you say green leaves, do you mean boiled or raw?—So far as iodine is concerned, it does not matter whether they are raw or boiled. Perhaps better eaten in the raw state.

A.815. I was told that iodine occurs very largely in some herbs in the Himalayas?—There is very little iodine in the soil of certain Himalayan regions. There is a good deal of iodine in the soils of the Nilgiris.

A.816. *Sir Thomas Middleton:* You mentioned mineral deficiency in certain parts in India, Bihar and Malabar. Were these deficiencies ascertained by yourself?—No. I learnt about the deficiencies in Malabar from Mr. Viswanath of the Agricultural Department of the Madras Government. With regard to the deficiency in Bihar, I found a reference to it in an article published in the *Agricultural Journal of India* in about 1917.

A.817. You agree that almost nothing is known about mineral deficiencies in India?—Apart from the work which Mr. Warth is struggling so courageously to do at Bangalore there is no work so far as I am aware being done on this subject. I have recently visited Mr. Warth and I am very greatly impressed not only by the magnificent work he is doing under very difficult circumstances but by the great necessity for the extension of his work on the lines laid down by him.

A.818. You are aware that Dr. Orr, who has specially worked on this subject, has indicated the great danger of mineral deficiency in the rapidly growing animal?—Yes.

A.819. Does that suggest to you that if we in India are quite ignorant as to the extent of mineral deficiencies, there may be some danger in attempting to increase the size of our stock rapidly by improving the bulls?—Yes; it will be largely labour lost, because you may get an improvement in the first generation and thereafter the cross-bred stock will most certainly deteriorate.

A.820. Is there not a great danger of death in the first generation?—There is, I am speaking now from memory; I seem to remember having read that the mortality among these cross-bred animals is very much higher than the mortality in the country-bred animals.

A.821. That is the particular point to which Dr. Orr drew our attention, in the recent report on Kenya?—Was it?

A.822. You said in connection with livestock much more work has been done on minerals than on vitamins?—Yes.

A.823. Is it not the case that Dr. McCollum started the work on minerals and then went on to vitamins?—Dr. McCollum originally started with food mixtures generally; vitamins were only discovered shortly before the War.

A.824. Within the last eight or ten years a great deal of work has been done?—He first started with minerals and then went on to vitamins.

A.825. In Great Britain have you heard of the work of Drummond, Zilva and Golding? They are working on domestic animals?—They are.

A.826. In fact the work on vitamins was much more substantial in volume than the work on minerals until within the last two or three years?—Within the last few years, especially in 1925, there has been a great output of work.

A.827. Investigators originally began working on vitamins and found that sometimes vitamin was not as important a factor as minerals; they switched on from vitamin to minerals about 1923?—Quite so.

A.828. Is it now definitely accepted that vitamin E does exist?—It is a recent arrival in the vitamin field; it has been accepted.

A.829. You do not suspect that it is vitamin B?—My own definition of 'vitamin' is a wide one; I mean by it all those substances in food which

exist in very small quantities whether they are organic or inorganic of which we do not yet know the action.

A.830. You have no proof as yet that old canal irrigation affects the quality of wheat?—Not as yet. It is with regard to loamy soil that I made that statement.

A.831. If we get such results as have been got by you and Dr. Norris in Coimbatore, it is difficult to accept the view that canal irrigation would not have an effect upon the quality of the crop?—You think it would have an effect?

A.832. Yes?—As I said, this work is still in progress.

A.833. Indirectly through its effect on the mineral constitution of the soil?—Obviously the quality of the soil and the kind of soil are going to have a great effect. We are going to find, I think, different effects on loamy soil and sandy soil.

A.834. You used one very illuminating word when you were talking of the addition of vitamin or the need for vitamin; you referred to the "spark" of the vitamin being wanted to make the rice effective. I think the illustration is a familiar one. Would you agree that if we use the metaphor of the car we might compare the effect of the rice to the influence of the petrol in the working of the car and the vitamin to the sparkling plug?—That is what I said.

A.835. Then, you agree that provided the rice has the necessary addition it is a most valuable food?—Yes.

A.836. Would you agree, to use a common phrase, that one of the reasons why wheat is so much more valuable universally than rice is that the one is more or less a fool-proof food and the other is not?—That is a very good expression. Whole wheat is a fool-proof food. The energy value of rice and wheat in equal amounts is precisely the same. For instance, one ounce of rice has a calorific value of 104, whereas one ounce of wheat has a calorific value of 103. But the difference in the nutritive value of the two grains is enormous.

A.837. *Sir Henry Lawrence:* If a man eats wheat he will find all the necessary elements for his nourishment provided he takes milk. But if he eats nothing but wheat he also will get ill?—Yes. In much the same manner as if you give the engine of your car petrol but not enough oil it will get out of order. Similarly if you give a man only wheat, you will cause him to get ill. You must have a natural balance in all these things. One of the great troubles in this country is that people cannot provide themselves with the other substances to make good the deficiencies of rice.

A.838. If you have to put in this natural balance, I do not understand what you mean by "fool-proof?—Wheat is in itself fool-proof; but it does not in itself constitute a complete food.

A.839. You cannot injure it?—No, unless by making it into wheat flour.

A.840. *Sir Thomas Middleton:* Is it not the case that the feeding of cattle and goats on village refuse is usually accepted as a proof of mineral deficiency?—It is usually.

A.841. So that wherever such a state of affairs is common the position ought to be closely investigated?—It ought to be; it is certain that there is a deficiency.

A.842. *Dr. Hyder:* I want to put a few practical questions with regard to this matter of nutrition. You said to the Chairman that you had no one to whom you could hand over your work. I wonder whether you are acquainted with the internal working of Indian Universities. Supposing our M.Sc.'s in Bio-chemistry, medical graduates, or agricultural graduates, were placed under you for training, could you initiate them into the methods of research, and go away with the confidence that they would carry on your work?—Do you ask me whether I could do this?

A.843. No. I ask whether you think that graduates who come out of our Universities with Degrees in Bio-chemistry, Physiology or Medicine could undertake work of the kind which you are carrying on?—My present opinion of such Indians as have served under me is that nutritional work particularly appeals to them, and personally I would be hopeful that amongst, say, every hundred men, who would pass through my laboratory there would be seven or eight who would be capable of undertaking original research in nutrition. I should not expect to find very many more. But those hundred have not passed through my hands, and until you see a man working, how he shapes and what thoughts arise in his mind when he sees a piece of work in front of him, you cannot say how he will turn out.

A.844. Is the University of Madras taking interest in your work?—I know that the medical profession of Madras generally takes a very great deal of interest in this work.

A.845. I wonder whether they have a Chair for Bio-chemistry in the University of Madras?—I do not know whether there is or there is not at the present time, but a Chair for Bio-chemistry is a very important addition to any University.

A.846. Passing on to another point, you know that some Indians have taken to European modes of living. I was wondering whether they were not after rising from one pit going to fall into another pit?—Many of them would be out of the frying pan into the fire.

A.847. You know that lemons are very largely used in this country. As soon as people become Europeanised they take to aërated waters, such as lemonades, and tinned foods, and also perhaps to polished rice. I was wondering whether the higher incidence of disease among educated Indians was due to their adoption of European ways of living?—In answer to this question I would say that each Commissioner who cross-examines me suggests other lines of nutritional research. In order to answer your question, it is necessary to extend the facilities for the investigation of such nutritional problems.

A.848. For instance, healthy and big-boned students from the north who come from their villages and are drafted into these colleges and Universities lose their vitality; that is my experience as a teacher in a Northern University. I was wondering whether the change was due to their adoption of European ways to some extent?—That is one of the things which we will be very happy to ascertain for you provided you give us your help to start an institute of nutrition.

The Chairman; Probably Dr. Hyder may be content to know that it may not be due to their adoption of European customs; there may be deficiencies in their diet not necessarily present in European diet.

A. 849. *The Raja of Parlakimedi:* You say beriberi is confined entirely to the East Coast of this Presidency; is it because it is a rice eating area?—Yes; beriberi occurs only within about 45 miles of the coast in the rice growing areas; it exists in the North East Coast of this Presidency, from Ganjam downwards.

A.850. There are, of course, favourable climatic conditions for the production of the disease?—The climatic conditions are certainly favourable for its production.

A.851. Have you got the full history of the beriberi disease?—We have succeeded during the last year in producing true beriberi in my laboratory; we have had 175 cases of it produced in animals, and I think now we can safely say that we know a great deal about it; we certainly know how to prevent it but whether we shall be able to find the actual causal factor of the disease remains to be seen. It is not a matter of very great practical importance. Whether we say that beriberi is due to an undiscovered substance X and whether we find that substance or not, we certainly know how to prevent the disease.

A.852. Is there any objection on the part of the department to have all that published in the vernaculars?—No; I think that is one of the reasons

why the work on this subject should be extended; there should be a Publicity Department as part of a Department of Nutrition. All these things which we ascertain in the course of our work should be put into simple language and widely published in the vernacular papers.

A.853. Can it be undertaken by any private individuals on application?—I should think it can be; I do not see any reason why it should not be, but that is a matter, of course, for the authorities concerned to decide.

A.854. *Sir James MacKenna:* I understand you are of opinion that the work you are doing at Coonoor and the work that Mr. Warth is doing at Bangalore and the work that is being done at Coimbatore on nutrition should be linked up?—Yes.

A.855. Would you like that work concentrated in one institute?—Not necessarily so.

A.856. You think it is possible to work up a link between the three existing agencies?—Yes.

A.857. Or would you prefer to have the whole thing under one roof?—I do not see any particular point in that; there is more room for expansion of the work as it exists at present than if all the three were situated in the same building. For instance, work on animal nutrition would have to go on being done in Bangalore, as there is no space for it at Coonoor. The work on human nutrition would have to go on being done in a reasonably good climate, because after all the output of work is entirely dependent on the man doing it, and he will do much better work if he is in a reasonably good climate than he will if he is in a bad one; that is the reason why I am doing my work at Coonoor; it would not suit me so well to do it elsewhere.

A.858. You would not like to have a central institute on nutritional research which would be working through all these three branches as at present?—Yes.

A.859. The relations are apt to break down if we merely link them up; you would have no objection to calling it a central institute on nutritional research working in all these three branches?—No.

A.860. Have you sufficient work for yourself and a full-time Bio-chemist?—I have sufficient work for half a dozen Bio-chemists.

A.861. You emphasise the very considerable possibility of getting capable young Indians to carry on this work, but the facilities for teaching would not be so great if the work is scattered in different places as they would be if you had a central institute?—Any young Indian taking up this work would have to take up one department of it; if he came to me, for instance, to do human nutrition, he would probably stick to it for the rest of his life; he could always visit the other centres and see what is going on there for educational purposes.

A.862. From that point of view, a scattered arrangement would not be any good?—I do not think so; it is an important matter for instance to extend the work at Coonoor. The jam factory is a building I wish to acquire, because, as I told the Chairman, it is very suited for work on nutrition, and it has been suggested to me by the Director of Agriculture of the Madras Presidency, that it would be an excellent thing if the work which Mr. Viswanath and myself are doing could be carried on by a Bio-chemist of the Agricultural Department, who, if he had the buildings of the jam factory, could do so under my direction.

A.863. The moment you have the jam factory, you begin by pooling in that place one of the connected branches of the work?—Not quite that. Their idea is that it would take the man a good year or more to learn how to do these experiments; it is not merely a case of having half a dozen rats and putting them in a cage; there is a great deal to learn, and what he would do, would be to learn himself and so teach others. That would be a means of spreading the work, so that routine testing of vegetable foods by biological assay could then go on being carried out by an Agricultural Chemist in other parts of the Madras Presidency.

A.864. Assuming that you do get the jam factory, you would still retain Coimbatore and just extend your own operations?—Yes.

A.865. *Professor Gangulee:* Apart from diseases that actually break out owing to deficiencies in diet are you of opinion that any such deficiencies leave the body defenceless against other diseases? I mean the response of the body to immunisation?—That has been definitely proven.

A.866. From that I gather that nutrition investigation will throw much light on preventive medicine?—Yes.

A.867. You said in answer to a question put by the Chairman that you are the only research worker in India in this nutrition investigation?—Yes, that is so.

A.868. And this subject of medical research is directly under the Government of India now?—I am working for the Indian Research Fund Association which, I believe, is a private fund, and it is contributed to of course by the Central Government.

A.869. I know; apart from the research fund that you are referring to, the whole question of medical research is under the Government of India directly. I mean the question of medical research as a general subject apart from the Indian Research Fund Association?—There is no other research financed except by the Research Fund Association, so far as I am aware.

A.870. It is rather difficult for me to understand why the Government of India has not taken adequate interest in that work; is it lack of equipment or lack of interest?—How do you mean the Government of India has not taken an interest?

A.871. Because, you say you are the only research worker in India?—The Government of India, I take it, has got other fish to fry as well as nutrition research.

A.872. Do the medical officers belonging to the superior grades receive training in research work in dietetics? Do those of them who come over to this country get any training?—If you mean young members of the I. M. S., nowadays they get intensive training.

A.873. Before they come over to this country?—Yes.

A.874. It is not lack of trained men? We can get trained men for the purpose, if you have the institute?—You can get men who know their A. B. C., they can read, so to say; no man is trained until he has been through the mill and attempted to do the work himself. Research itself is difficult; what I mean is that there are several kinds of research; the man may simply follow in the lead of somebody else.

A.875. And cannot take the initiative?—Yes. For research in this country we want men with imagination and capacity for initiating it.

A.876. Do you suggest that such workers cannot be found in the superior grades of the service?—No, I do not suggest anything of the kind. I consider still that there is no function of medicine which cannot be fulfilled by officers of the service to which I have the honour to belong.

A.877. Do the Government of India send men abroad, either to America or Japan, for training?—They sometimes do.

A.878. In 1923, I understand the Rockefeller Foundation made an offer?—Yes.

A.879. And the Rockefeller Foundation is an international organisation?—Yes.

A.880. Willing to co-operate with any body in any country for the purpose of training in this sort of nutritional research. Could you tell the Commission what the Government of India has done to avail itself of the unique facility offered by this international body?—That, I am afraid, I cannot answer, because I have not had any experience of the Secretariat of the Government of India, and I do not know what they have done in the matter.

A.881. You are aware of that offer?—I can aware of it.

A.882. I think three men were sent from this country?—Were there three sent?

A.883. To the Johns Hopkins University; what happened to these men when they returned?—I do not know; I think one was Major Shokey, he is now at the Haffkine Institute.

A.884. You are not aware of the conditions on which the Rockefeller Foundation made these offers?—I am not.

A.885. There was a proposal by the Government of India to start nutrition work in this country, and it was suggested to secure the services of Professor Saiki of Japan; are you aware of that?—I have heard that something of the sort was suggested. His services are quite unnecessary.

A.886. Could you tell the Commission at what stage the proposal now rests?—I do not know at what stage the proposal now rests; I know I have not succeeded in finding the name of Dr. Saiki mentioned in nutritional literature.

A.887. He is, I think, Director of the Imperial Institute in Tokio?—Yes.

A.888. Is there any definite proposal before the Government of India with regard to your work, either for its expansion or for its cessation?—One sends up one's proposals for the next year in the usual way; that is all one knows about it.

A.889. You are assisted in your work by a number of Indians?—I have three assistants.

A.890. Are you satisfied with them?—All of them are most admirable.

A.891. Can they do the statistics work well?—They cannot, but I have had the advantage of having the services of the Director of Public Health's Statistical Assistant, who has given me most valuable assistance.

A.892. Which are the most important from the point of view of deficiency, vitamins or glands?—I cannot say. Comparisons in regard to substances essential for metabolism are difficult. They are all equally important.

A.893. What are the criteria of a good diet?—It is a general question. The diet should be perfectly balanced in respect to proximate principles of the food which are proteins, carbo-hydrates, fats, salts, and water. It also should contain a sufficiency of vitamins without which, as I explained, the normal processes of metabolism are impossible. Those are the criteria of a good diet.

A.894. One word about this Indian Research Fund Association to which you made reference. In what sense do you think it may be designated as semi-official body or organisation?—I believe the Government of India contribute largely towards it. I understand it has a scientific advisory board, and the governing body of the Indian Research Fund Association has a number of officials working on it.

A.895. In the governing body, I do not find a single non-official. Does it consist of officials only?—I do not know. I am not familiar with its constitution, perhaps not so familiar as I ought to be; but to tell you the truth, I have not thought about it.

A.896. *The Chairman:* They send you the money and you do the work?—Yes.

A.897. *Mr. Calvert:* Are you in a position to venture an opinion as to how far poverty enters into this question of nutrition?—I am not in a position to do so. It is outside my kind of work.

A.898. Ordinarily one would expect that unpolished rice should be cheaper than polished rice and white flour?—Yes. But if people bought *atta*, they would not be doing themselves an injury, because *atta* is the better of the two.

A.899. In the case of the army rations, I think the rice eater's ration is actually more expensive than the *atta* eater's ration?—Yes.

A.900. In the case of a man not necessarily affected by poverty, it is a question of unsuitability of the actual diet?—Yes. Many of the better class of people in England feed themselves unsuitably.

A.901. Have you made a study of the food consumption by cultivators in the special tracts of the Punjab?—I have not.

A.902. There was an enquiry by a Colonel of the Indian Army Service Corps, the Inspector-General of Prisons, the Superintendent of the Mental Hospital and a Professor of Physiology, who discussed the dietary from various points of view. Do you think similar enquiries into the dietary of the rural classes would be of any help?—Yes, of immense help.

A.903. I see the army ration scales have been worked out to give a complete ration, with vitamin values also. Is that scheme approved by you?—It has not come to me for approval.

A.904. It was issued by the Director of Medical Services?—It has not come my way.

A.905. In answer to a question from Sir Henry Lawrence on this question of milk, you said that milk was a very important item; but in a very large tract of country in China, Japan, Burma and Siam, milk is not part of the diet at all. How do you reconcile that with your remark about milk?—I should imagine that the people in the tracts you refer to are not of good physique or that they use other foods, such as fish, which may to some extent compensate for the want of milk. For instance, in Japan there is more beri-beri than probably in the rest of the world, all the countries put together. Obviously, Japanese do not receive enough protein; otherwise, they would be bigger people.

A.906. You say that milk is very necessary; but still the Japanese and Chinese as a race have been in existence for some thousands of years?—There is no reason why they should not continue to exist but their physique is smaller.

A.907. The constitution of the Burman may be due to his not taking milk?—Yes. None of those countries are very healthy countries.

A.908. Is *dal* not an adequate substitute for milk?—Not for milk. It is an excellent substitute for mutton. It does supply a sufficient amount of protein; there is no substitute for milk.

A.909. *Dr. Hyder:* Have you ever seen a tall Japanese or Chinaman?—I have never been either to Japan or China.

A.910. *Mr. Kamat:* As national habits of diet cannot be changed in a day, I should like to know what advice, for instance, you would give to the Madras people to attain the same efficiency as the Punjab people, say, for example taking more pulses and *dals* in their food, for the time being?—The answer to that is this: that there is only a certain amount of pulse or *dal* which they can take. Everything over about 4 ounces of pulse will be useless. They cannot deal with it. The protein which the pulse provides they cannot assimilate. So it will remain in the intestines and will give rise, as Colonel McCay showed 14 or 15 years ago, to another sort of disease. So, even with the pulses there is no hope for them to rise to the same standard of physical efficiency as in the Punjab. If, however, they consume more milk and green vegetables, then they can attain a reasonable state of physical efficiency.

A.911. I want to know also the value of pulses *versus* meat. Can those, who do not touch meat and depend on pulses, have the same efficiency as meat-eating people?—Provided the rest of their diet is complete, provided they take a sufficient amount of milk, they will do admirably on pulses.

A.912. So the whole question comes back to milk?—Yes, it comes back to milk and to the balance of food.

A.913. *Mr. Calvert:* But milk is not part of the army ration?—The men get *ghi* in its place.

A.914. *Mr. Kamat:* There is just one question about publicity. Would it be possible to embody your results into school text-books in simple language,

including also the charts on a small scale?—It would be quite possible. In the institute of nutrition, which we are all thinking about, there will be some man who will be specially engaged in the production of these pamphlets, because it will take a man all his time to do it. It would not be possible for me.

A.915. With Indian assistants?—Yes.

A.916. For the benefit of the succeeding generations?—Yes, to the great benefit of India.

A.917. What is the amount of the annual grant made from the Indian Research Fund roughly?—I think including my pay, I get about Rs. 70,000 per year.

A.918. And if you want more money, I believe it will be available from this Fund?—When I have been actually working for the Fund I have not so far been stinted for money for my researches.

(The witness withdrew.)

The Commission then took oral evidence of Major-General F. H. G. Hutchinson for which see Volume III and then adjourned till 9-30 a.m. on Monday, the 30th November, 1926, in Calcutta. For the proceedings of meetings from 30th November to 7th December 1926 (excepting the evidence of Dr. E. H. Pascoe which follows), see Volume IV.

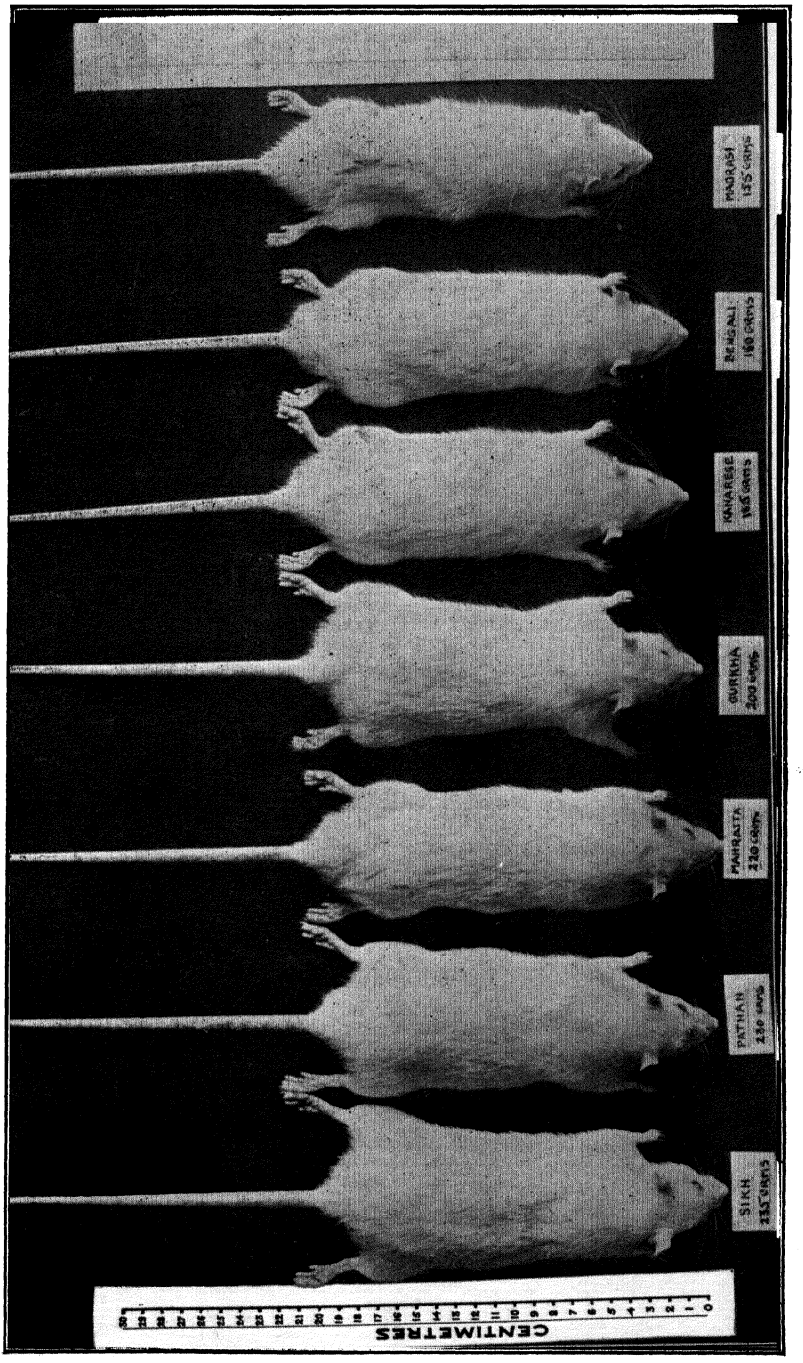

FIG. 1.

Shows the relative values of certain National diets of India (*vide* text of Evidence on page 101 and Chart E). The rats selected represent in each case the *average* weight of the animals in their particular group. Photograph taken on the 140th day of the experiment. Compare Chart E showing the percentage increase in body-weight on the 80th day of the experiment.

Lieut.-Col. R. McCarrison.

"Bad Diet"

FIG. 2.

Shows the effect on rats of a "Good diet" and a "bad one." The former was such as is used by the Sikhs; the latter such as is used by many Europeans of the poorer classes (*vide* text of Evidence on page 102). The latter diet is no better than the diets of Bengal and Madras; in some respects being worse.

Lieut.-Col. R. McCarrison.

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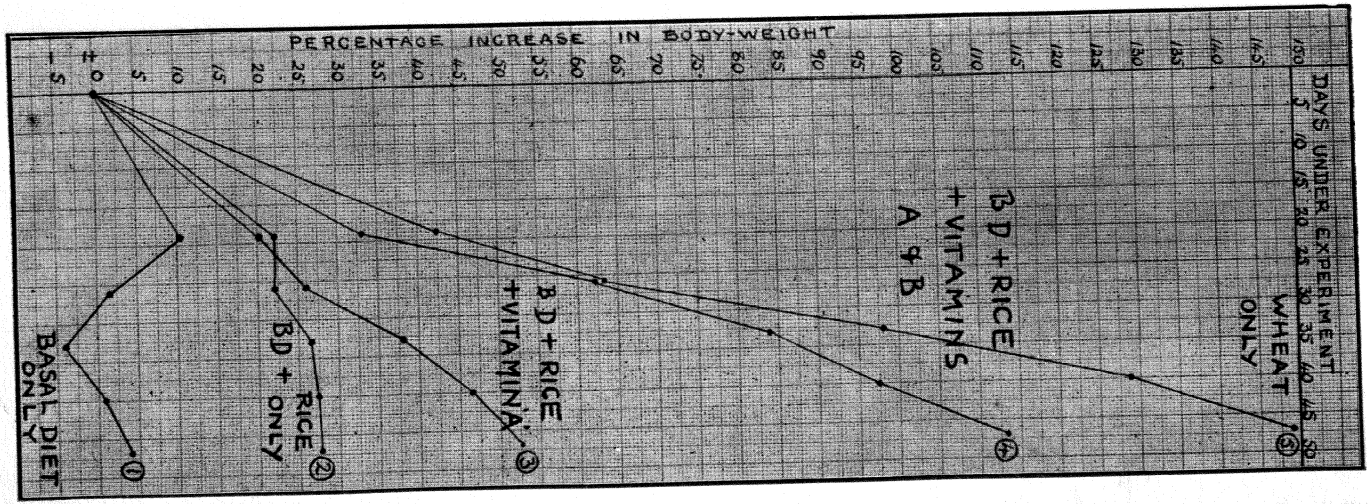
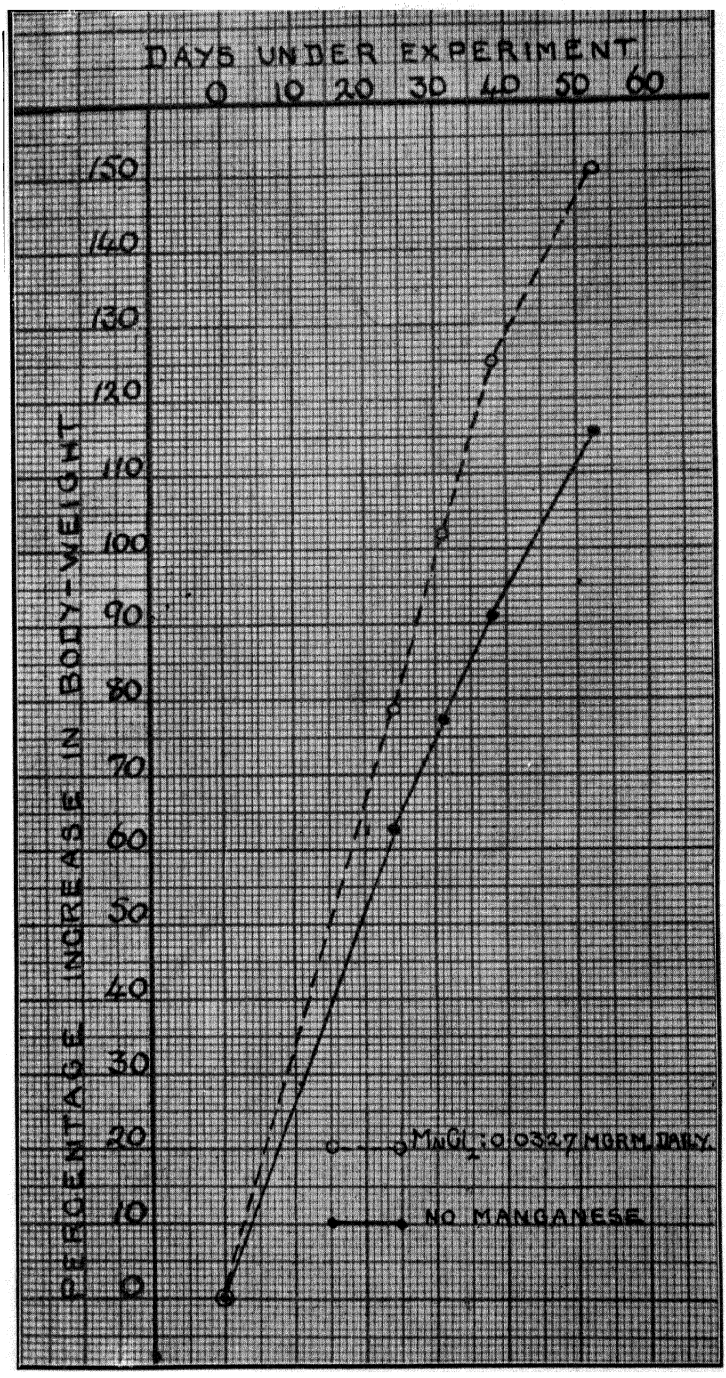
CHART B.



Five groups (six in each) of young rats of the same initial weight, age, sex, and growth potential, were fed on a basal diet containing proteins, fats, carbohydrates and salts in proper amount and proportion but without vitamins. One (1) received this diet only; a second (2) this diet *plus* one gramme of *whole rice* as the sole additional source of vitamins; a third (5) received the same diet *plus* one gramme of *whole wheat* as the sole additional source of vitamins. Note the remarkable difference in nutritive value between whole rice and whole wheat. The addition of vitamin-A to the diet containing whole rice (3) did not improve it greatly, while the addition of both vitamins A and B did (4); thus demonstrating the fundamental poverty of whole rice in these two vitamins. This addition did not, however, make the diet containing rice equal to that containing wheat. The reason being that rice is also poor in certain inorganic salts, notably manganese.

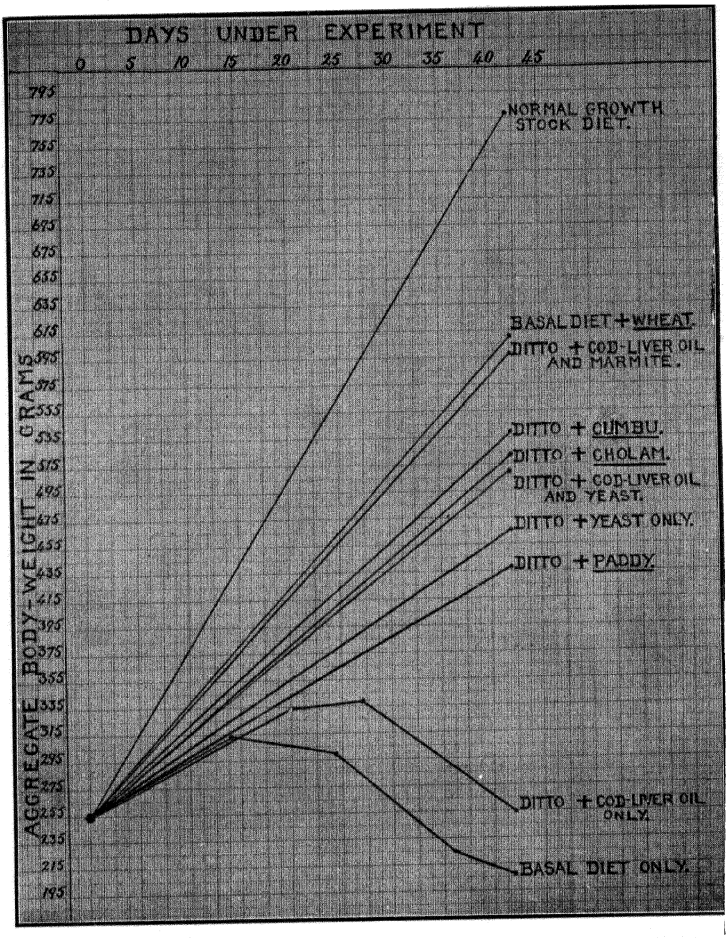
CHART C.



Two groups (six in each) of young rats of the same age, sex, initial weight and growth potential, were fed on a synthetic diet complete in every respect as regards proteins, fats, carbohydrates, salts and vitamins. But to the diet of one group manganese chloride was added in amounts proportionate to that present in a wheat-eater's diet. The pronounced effect of this small amount of manganese on the growth of the young animals is seen in the chart (in this and in all other experiments the similarity in growth potential was ensured, as far as possible, by selecting the animals for each group from a number of different litters).

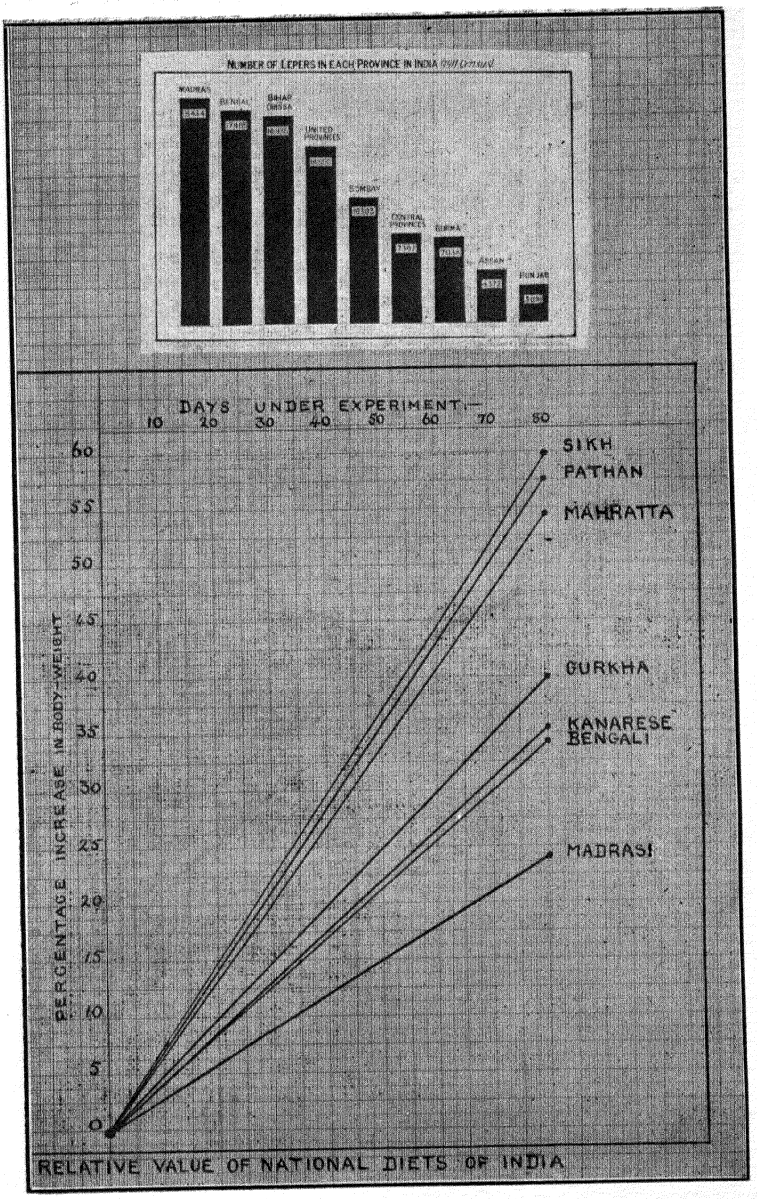
Lieut.-Col. R. McCarrison.

CHART D.



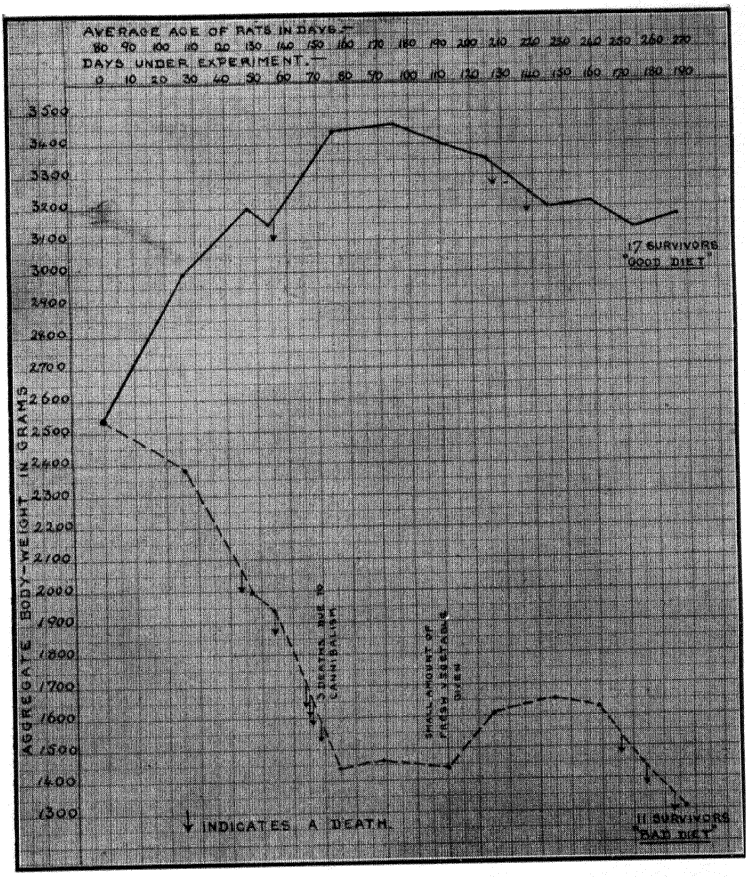
This shows (1) that no growth results from a basal diet which contains no vitamins although it is complete in all other respects (lower curve); (2) that the addition of cod-liver oil to this diet—which provides vitamin-A—does not improve matters much (second curve); (3) that the addition of cod-liver oil and yeast which provides both vitamin-A and vitamin-B does result in fairly good growth (fifth curve), this growth being better still if the source of the vitamin-B is marmite instead of yeast (eighth curve); (4) that the addition of yeast alone (fourth curve) gives almost as good growth as yeast and cod-liver oil (fifth curve) showing that the olive oil used in the basal diet contained some vitamin-A; (5) that when one gramme of wheat or *cumbu* or *cholam* or paddy was added to the basal diet as the sole additional source of vitamins, wheat was found to be by far the richest in those substances so necessary for growth, and paddy by far the poorest; while the other two grains occupied an intermediate position in this regard; (6) that one gramme of wheat gave as good growth as cod-liver oil and marmite put together and better growth than cod-liver oil and yeast and (7) that no artificial diet was as good as the natural "stock diet" used which consisted of *chapattis* of *atta*, sprouted grain, milk, butter, green leafy vegetables, fruit, tubers, roots and fresh meat once a week.

CHART E.



Seven groups of twenty young rats of same initial weight age, growth potential, and sex, were placed in separate cages and under precisely similar conditions of life. Each group was fed on a diet such as is used by the race the group represented. The diets of the wheat-eating races—Sikhs, Pathans and Mahrattas—were the best, in conformity with the fine physique and military history of these races. The diets of the rice-eating races—Bengalis and Madrasis—were the worst, in conformity with their smaller stature or poorer physique and poorer capacity for hard work. The addition of such articles of food as milk, butter, meat, etc., greatly improved the rice-eater's diet. Contrast, for example, the Madrasi's diet with that of the Gurkha (the latter eating meat more frequently). The Kanarese are millet (*ragi*)-eaters; the Mahrattas use half rice and half wheat or *bajra* with milk and milk-products. The upper chart shows the much higher incidence of leprosy in the more poorly nourished races.

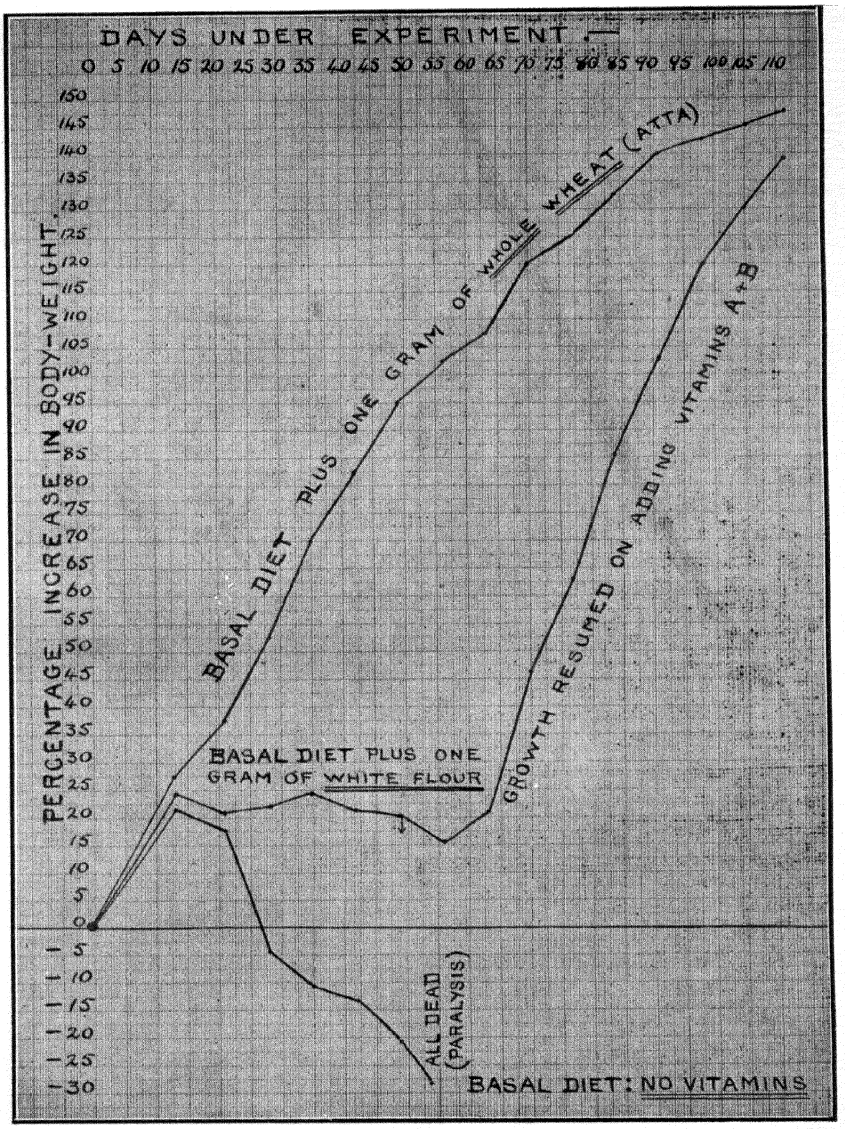
CHART H.



This shows the difference in nutritive value and health-sustaining properties between a "Good Diet" and a "Bad Diet." Two groups of 20 half-grown rats of the same initial weight and growth-potential were fed on these two diets, there being the same number of males and females in each group. The "Good Diet" consisted of *atta chapattis*, milk, butter, green vegetables, sprouted gram, raw potato, carrot, tomato (as substitute for fruit), water and fresh meat once a week. The "Bad Diet" consisted of white bread, tea, sugar, margarine, a little milk to add to the tea, preserved meat, boiled vegetables, jam. Each group ate as much as they wanted. The weight curves show how the former flourished and how the latter did not. No doubt the food preservatives (sulphurous acid, boracic acid and formaldehyde) present in some of the ingredients of the "Bad Diet" contributed to its ill-effects. These preservatives are present in jam, margarine and preserved meat.

Lieut.-Col. R. McCarrison.

CHART H-2.



This shows the difference in nutritive value between whole wheat flour (*atta*) and American white flour. Three groups of young rats (six in each) of the same age, sex, growth, potential and initial weight, were fed on a basal diet complete in every respect but devoid of vitamins. One group (lowest curve) received this diet only and the animals failed to grow, lost weight and died of paralysis of the hind limbs. A second group (second curve) received this diet *plus* one gramme of American white flour as the sole additional source of vitamins. The animals in this group grew for the first 14 days of the experiment when growth ceased. They did not, however, become paralysed showing that white flour contains some anti-neuritic vitamin (hence beriberi is rare in Europe and America) but was very poor in a growth-promoting vitamin. A third group received the same basal diet *plus* one gramme of whole wheat flour (*atta*). At the point marked with the arrow on the second curve vitamin-A was added to the white flour diet. It did not improve the rate of growth. At the end of a fortnight vitamin-B was added.

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CHART J-1.

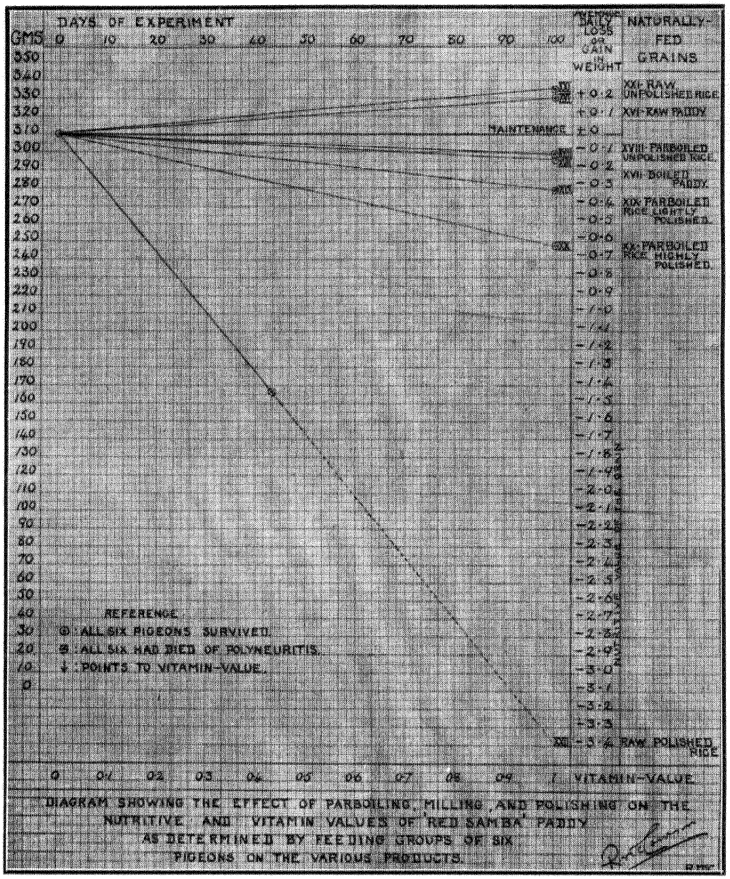

DIAGRAM SHOWING THE EFFECT OF PARBOILING, MILLING AND POLISHING ON THE NUTRITIVE AND VITAMIN VALUES OF 'RED SAMBA' PADDY AS DETERMINED BY FEEDING GROUPS OF SIX PIGEONS ON THE VARIOUS PRODUCTS.

This shows the effect of parboiling, milling and polishing on rice This was tested by feeding groups of pigeons of the same initial aggregate body-weight (and of an average body-weight of 310 grammes) on the various products of a "red *Samba* paddy." The birds were fed exclusively on these products for a period of 100 days or until death. The *raw* unpolished rice is the best being slightly better than the raw paddy itself, due, no doubt, to the consumption of a certain amount of unnutritious husk with the latter. In both cases the diet keeps the birds above "maintenance level" (that is, they do not lose weight). Parboiling lowers the value of the rice to some extent (it preserves its vitamin-B but causes loss of vitamin-A): and milling and polishing of the parboiled rice further reduces its value due to loss of vitamin-B and other substances in the process. But even the highest degree of milling and polishing does not remove all the vitamin-B from parboiled rice while it removes almost all if the rice is not parboiled but is milled and polished in the raw state (bottom line in chart). The arrow on this line points to the "vitamin value" of the raw polished rice: 0·38. It ought to be 1·0 to ensure that the birds will be kept at maintenance level.

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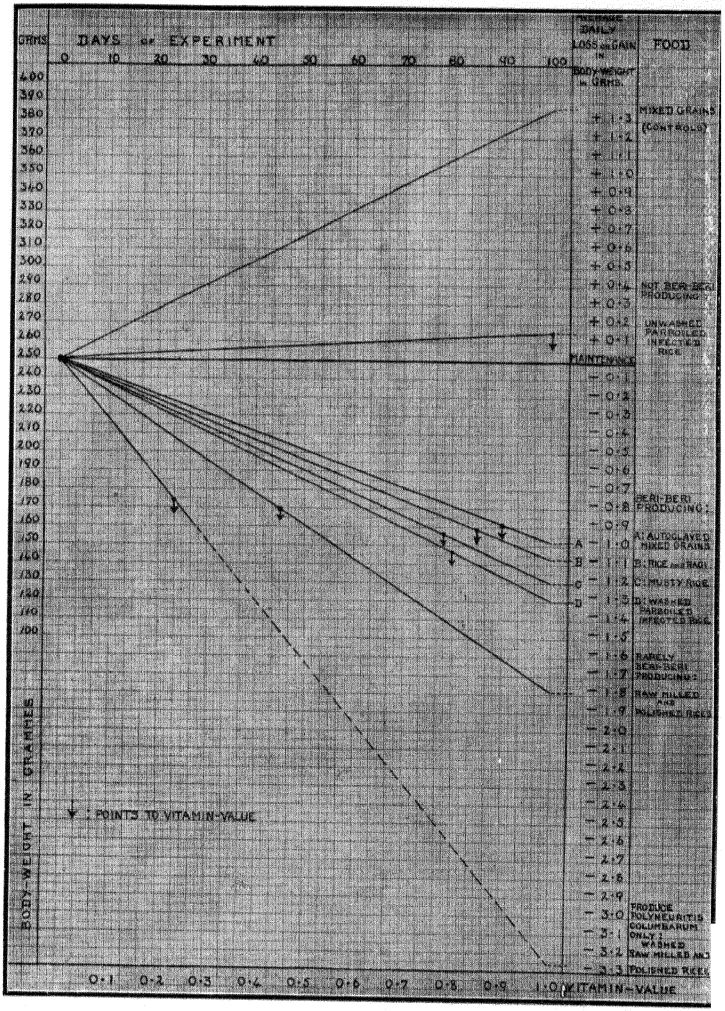
CHART J-2.



This shows the optimum food conditions for the production of the disease called beriberi. This disease is a condition of polyneuritis, with heart disease and dropsy. The basal factor in its causation is a diet—usually composed largely of polished rice—which contains "too little" vitamin-B for "maintenance" polished rice alone does not cause it (lowest line in chart) because the vitamin value of this rice is so low (0·24) that the animals cannot live at all. The disease only arises when the diets, such as those noted as A B C and D on the chart, have vitamin-B values which happen to lie between 0·75 and 0·9—the amount of vitamin-B required for "maintenance" being represented as 1·0. So that if a little *dal* be added to the diet of polished rice so as to raise the vitamin-B value of the diet to say 0·8 then beriberi will arise.

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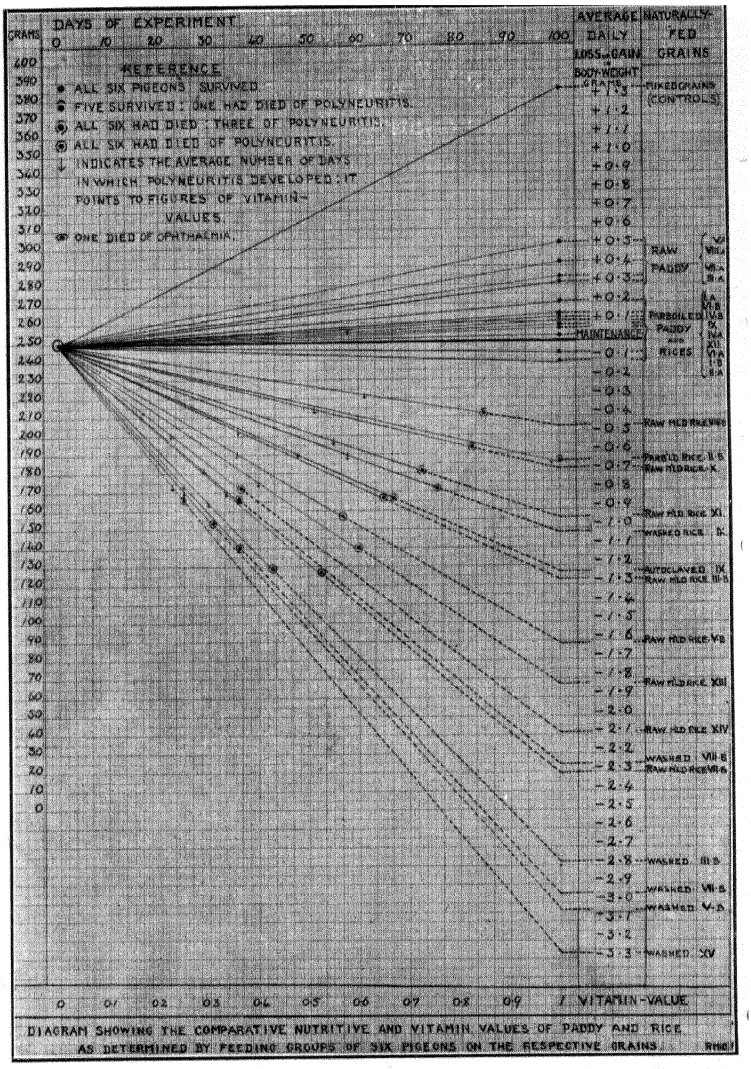
CHART L.



This shows in the same way the comparative values of some 28 rices in common use in India. It will be noted how greatly they differ, due in the main to the degree of milling and polishing to which they have been subjected. The four bottom lines show the disastrous effects of much washing of raw milled and polished rice prior to its consumption. This is due to the fact that vitamin-B is soluble in water, so that any amount of this substance left in the rice may be washed out of it. Other important substances are also washed out in this way: notably phosphorus.

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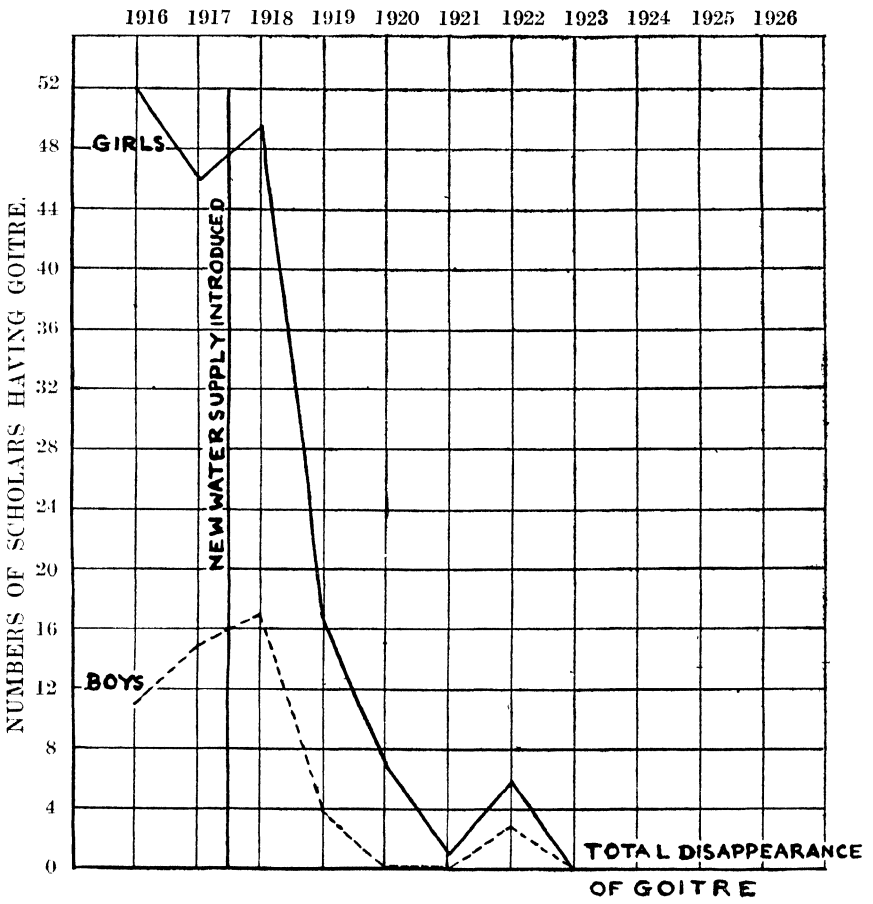
CHART N.

GOITRE AT THE ROYAL LAWRENCE MILITARY SCHOOL, SANAWAR.



This shows the eradication of goitre from a school (of 500 scholars) in the Punjab where goitre had prevailed since the establishment of the school after the Mutiny.

Lieut.-Col. R. McCarrison

CHART P-1.

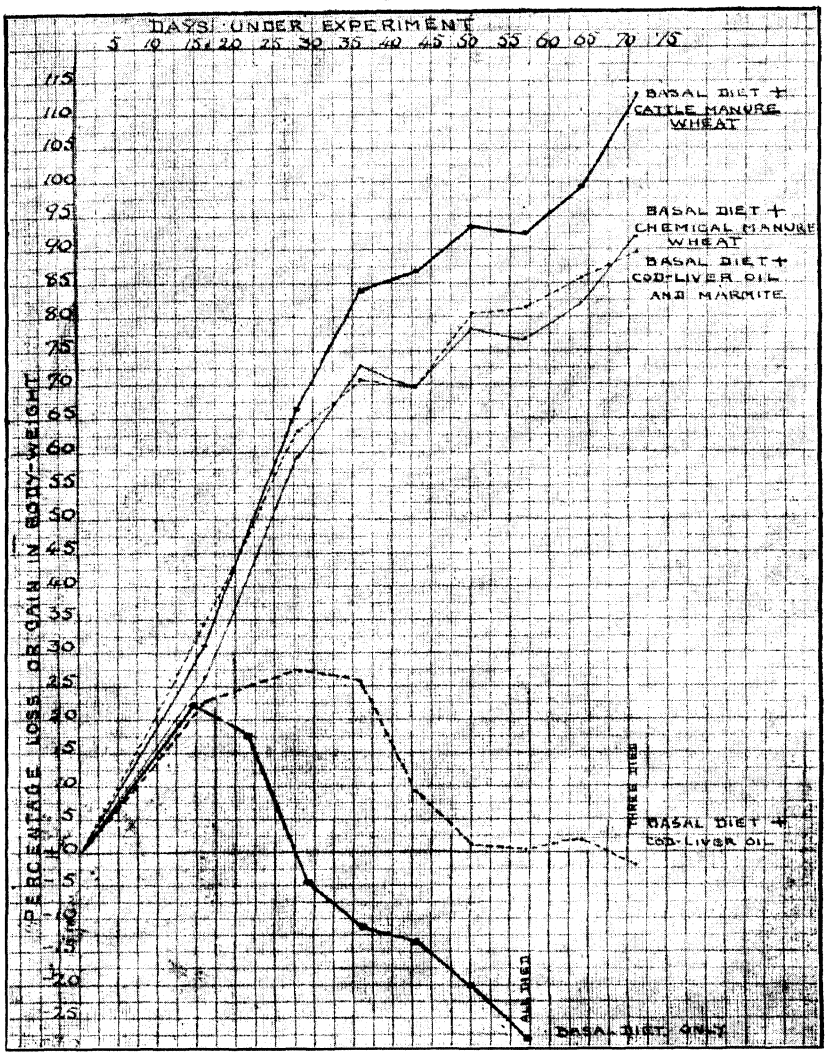
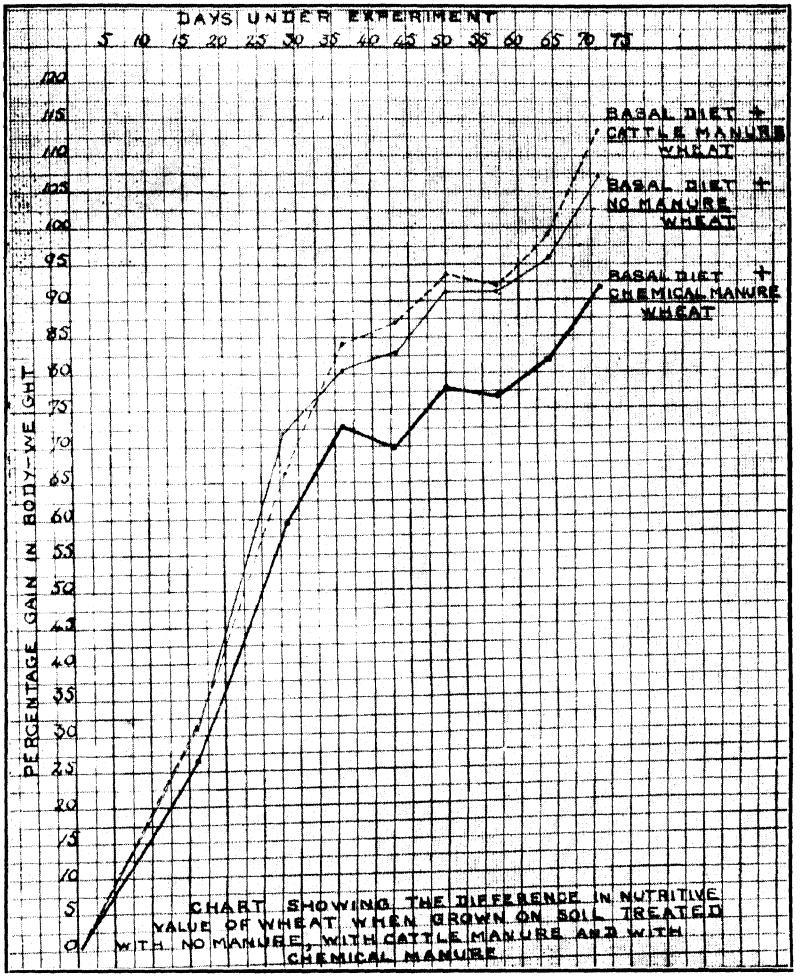


Chart showing the difference in nutritive value between "cattle manure wheat" and "chemical manure wheat."

This shows the effects of manure on the nutritive and vitamin value of wheat. Five groups of young rats were used: one received a basal diet only which was complete in every respect but had no vitamin-B and very little vitamin-A, no growth resulted (bottom curve); another had the same diet *plus* cod-liver oil to provide vitamin-A, again no growth resulted but death was delayed; a third had the same diet *plus* cod-liver oil (to supply vitamin-A) and marmite (to supply vitamin-B) (3rd curve) when good growth resulted; a fourth had the same diet *plus* one gramme of wheat, grown on soil manured with a *complete chemical manure*, (as the sole added source of vitamins) and good growth resulted equal to that given by cod-liver oil and marmite together (4th curve from bottom); a fifth had the same diet *plus* one gramme of wheat, grown on soil manured with *cattle manure*, (as the sole added source of vitamins), better growth resulted. The wheat grown on soil manured with cattle manure is thus approximately 17 per cent better than when grown on the same soil manured with chemical manure. The same result has recently been obtained with oats and *arhar* grown at Pusa.

Lieut.-Col. R. McCarrison.

CHART P-2.



This shows the relative values of the same wheat when grown on the experimental plots at Coimbatore which received cattle manure, chemical manure and no manure at all. It is remarkable that though the yield in grain from the " no manure plot " is so much lower than either of the others, in nutritive and vitamin values it is higher than the chemically manured produce. The same result has recently been noted for oats and *arhar* grown at Pusa; so it is not a chance result.

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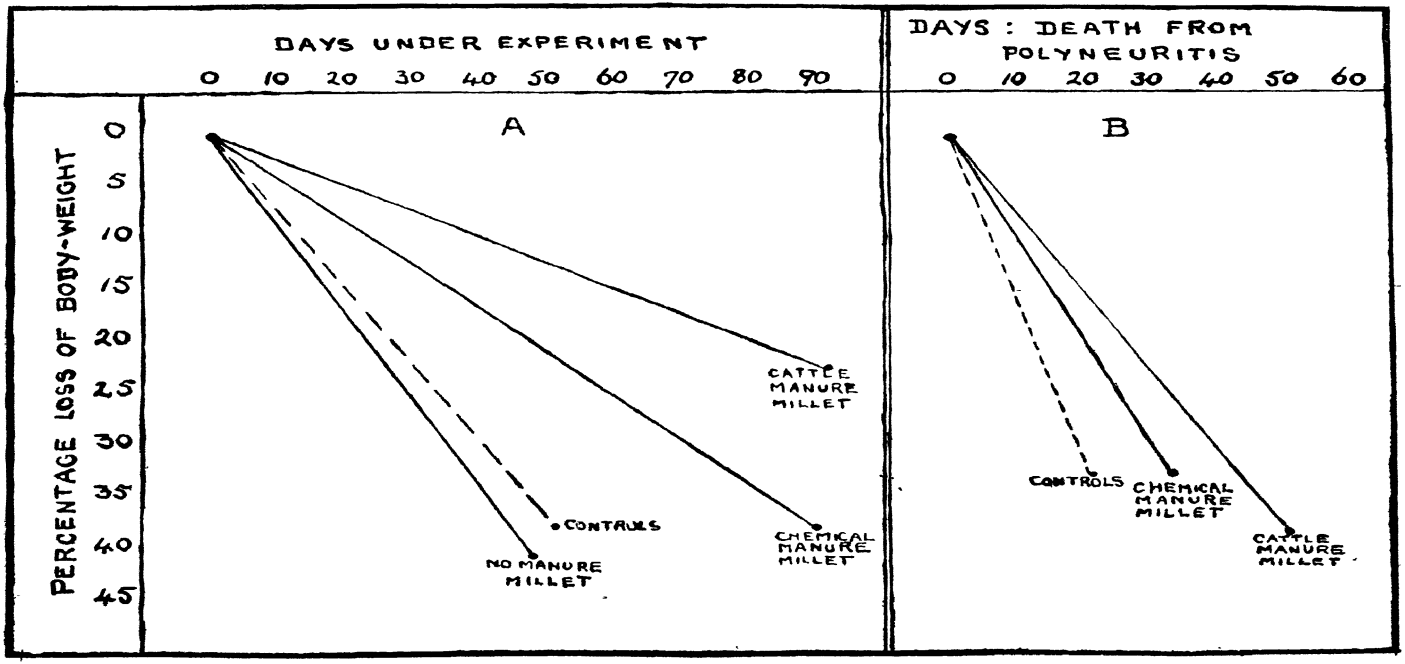
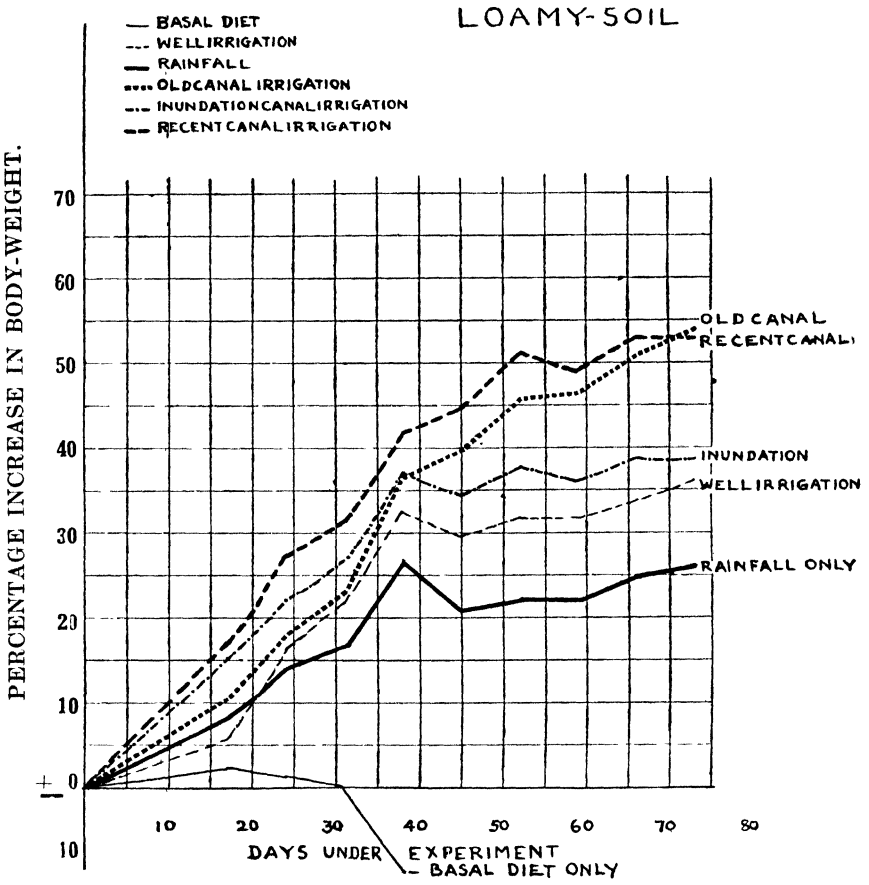


CHART Q.

Chart A showing the percentage loss of weight in groups of pigeons, of the same initial aggregate weight, when fed on a basal diet of rice to which 'cattle manure millet' or 'chemical manure millet' or 'no manure millet' was added in the same amount (*vide* text). The controls received the basal diet only. Note that the addition of the 'no manure millet' actually increased the rate at which body-weight was lost and hastened the time of death as compared with controls which received no millet. 'Cattle millet' was markedly superior to either of the other millets in preventing the loss of weight caused by a diet of rice.

Chart B shows that 'cattle manure millet' was richer in vitamin B than 'chemical manure millet' since, when added in the same amount to a basal diet of raw, polished, washed and autoclaved rice, it delayed the onset of polyneuritis for a longer time. If the vitamin B value of 'cattle manure millet' be taken as 1 that of 'chemical manure millet' is approximately 0·66.

CHART R-1.



This shows the effect of different forms of irrigation, or water-supply, on the nutritive and vitamin values of wheat from the Punjab. The same wheat was used throughout but grown on loamy soil irrigated in different ways. The same technique was followed: groups of rats of the same age, weight, sex and growth potential, were used and fed on a basal diet which was complete in all respects except that it contained no vitamin-B and little vitamin-A. One group (the controls) received this basal diet only and did not grow; the other groups each received 1 gramme per animal daily of the whole wheat grown on loamy soil irrigated in different ways. The experimental work on this subject is not completed and definite conclusions cannot as yet be drawn, but this and the succeeding figures show that water-supply does make a difference to the nutritive value of the wheat, and that this difference depends to a considerable extent on the nature of the soil.

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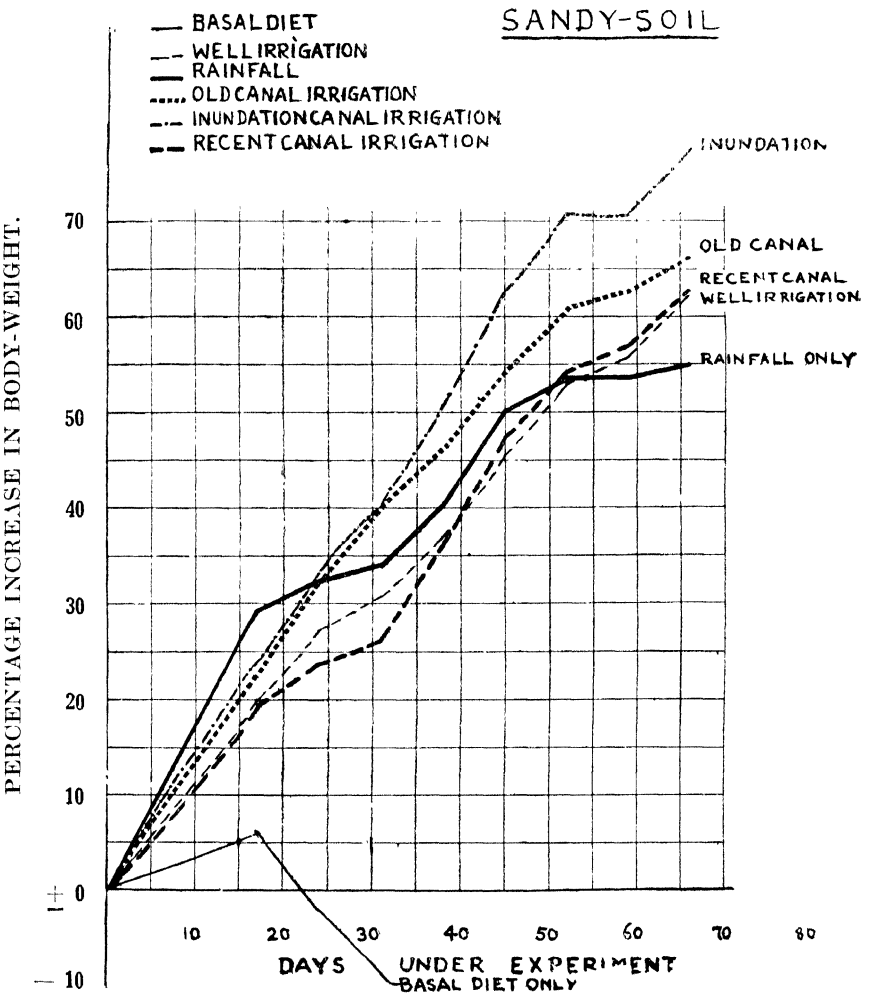
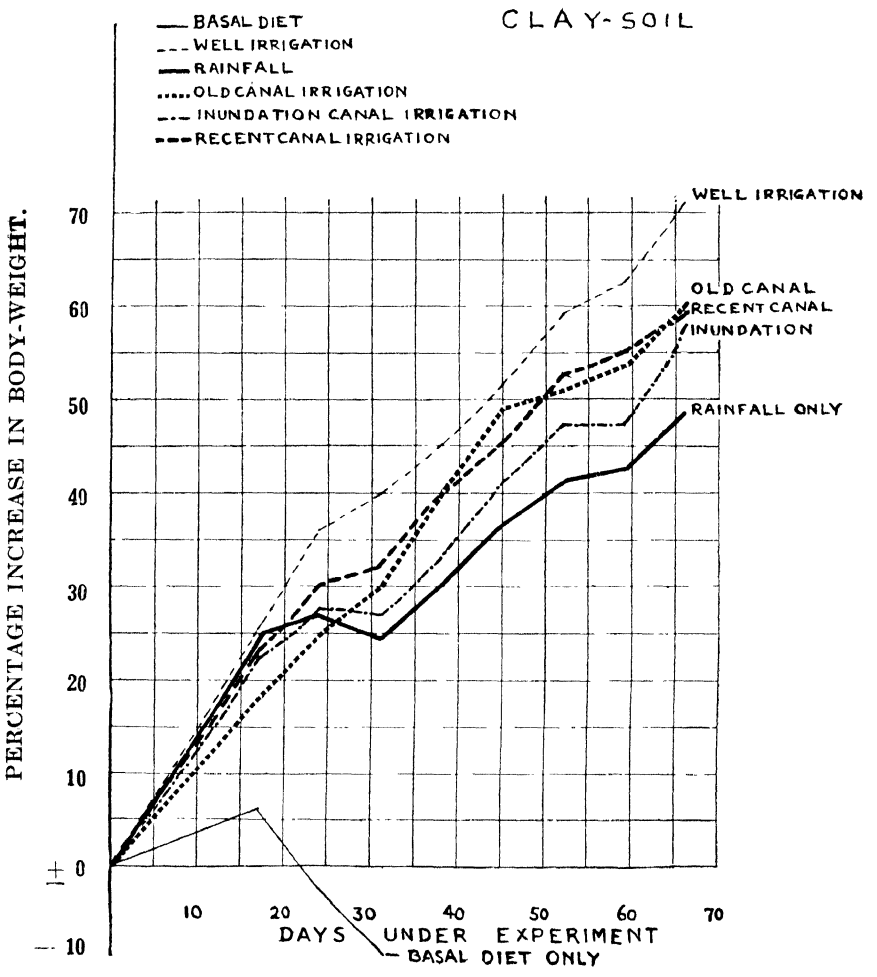
CHART R-2.



Same legend as for Chart R-1. In this case the wheat was grown on *sandy soil.*

CHART R-3.



Same legend as for Chart R-1. In this case the wheat was grown on *clay soil.*

Lieut.-Col. R. McCarrison.

Tuesday, December 7th, 1926.

CALCUTTA.

PRESENT:

The MARQUESS OF LINLITHGOW, D.L. (*Chairman*).

Sir HENRY STAVELEY LAWRENCE, K.C.S.I., I.C.S.
Sir THOMAS MIDDLETON, K.B.E., C.B.
Rai Bahadur Sir GANGA RAM, Kt., C.I.E., M.V.O.
Sir JAMES MACKENNA, Kt., C.I.E., I.C.S.
Mr. H. CALVERT, C.I.E., I.C.S.
Raja Sri KRISHNA CHANDRA GAJAPATI NARAYANA DEO of Parlakimedi.
Professor N. GANGULEE.
Dr. L. K. HYDER.
Mr. B. S. KAMAT.

Mr. J. N. GUPTA, I.C.S.
Rai A. C. BANNERJI BAHADUR } (*Co-opted Members.*)

Mr. J. A. MADAN, I.C.S.
Mr. F. W. H. SMITH. } (*Joint Secretaries.*)

Dr. E. H. PASCOE, M.A., D.Sc., F.G.S., F.A.S.B., Director, Geological Survey of India.

Replies to the Questionnaire.

QUESTION 10.—(*f*) The few remarks I have to offer under this head form a corollary to Dr. Watson's paper published in a Supplement to the *Indian Trade Journal* (Vol. X, 27th August, 1908). The prevention of the waste of this valuable fertiliser evidently depends upon the availability of an equally cheap and efficient substitute. Of the three possible substitutes Dr. Watson showed that according to prices in 1908 kerosene was out of the question, and that wood could compete only in Madras, where it was a cheaper fuel, and in Bengal, where its price was much the same as that of cowdung cake. Presumably wood could have competed also in Upper Assam and the jungly parts of Burma. Dr. Watson showed that the selling price of cowdung cake was entirely fictitious and that its real value was at least 2½ times greater. Cowdung cake, in fact, ought to have been the dearest fuel—dearer even than kerosene oil (see *Indian Trade Journal*, Vol. XIII, p. 307; June 17th, 1909).

I have been unable to obtain in time figures regarding the present-day price of cowdung cake. The average price of Bengal coal was about Rs. 6-12-0 in 1908 and about Rs. 7-9-0 in 1925. I shall assume that the present ratio between the prices of cowdung cake and coal differs to no large extent from the ratio in 1908. Dr. Watson's figure showed that in most parts of India coal was a closer and more promising competitor, and it is on this that I would submit a few remarks.

If cowdung cake were estimated at its real value, we may assume that none of it would be used for fuel purposes, for coal, coke, wood and oil would be considerably cheaper. The more the value of cowdung cake could be brought home to the agriculturist, the higher would rise its price. A point would soon be reached at which other fuels would supplant it, and the first

Were an adequate market and a suitable price obtainable, there is little doubt that large quantities of soft coke—a fuel acceptable in nearly every way to the Indian villager could be placed upon the market and distributed by railways and ultimately by bullock carts assisted perhaps in some cases by steam road lorries or motor lorries. Government could assist by improving the roads where necessary. There are in the Raniganj, Jharia and Bokaro coalfields thousands of millions of tons of second grade coal, much of which would yield a soft coke. The danger to the scheme lies in the absorption of profits by middlemen, and a maximum selling price would probably have to be fixed either by the coal companies in combination or by Government; in the latter case some sort of licensing system would perhaps be necessary.

The ideal medium for the distribution of coal would be canals. Unfortunately, navigation canals, on the whole, have met with indifferent success financially in India. Nevertheless, I think the question of tapping some of the large Damodar Valley Coalfields by canal is worth careful investigation. Barges thus brought down to the Ganges could be towed by tugs to the populous tracts of the Ganges Valley.

The whole question seems to depend upon the education of agriculturists to the value of cowdung cake and thus raising it nearer to its actual value. If this could be done, the substitution of coke or perhaps in some cases coal would, I think, follow as a matter of course. The question of bringing home to the agriculturists the value of cowdung cake is outside my scope. Really informative propaganda, by which I mean propaganda which not only tells the enquirer what he ought to do, but also why he ought to do it, is perhaps the most important line of action.

It might be worth while for Government to appoint a small committee to consider the whole matter, the committee to include an agriculturist, a geologist and an engineer, with powers to co-opt.

Oral Evidence.

A.919. *The Chairman:* Dr. Pascoe, you are in charge of the Geological Survey of India?—Yes.

A 920. You have provided the Commission with answers to certain questions in our Questionnaire and you are also, I think, responsible for the production of a memorandum on India's resources in mineral fertilisers, which memorandum was forwarded to us by the Central Government sometime ago. Have you any remarks of a general character which you wish to address to the Commission at this stage?—No. All I have to say I have put into my note in answer to the Questionnaire.

A.921. Your memoradum in answer to our Questionnaire is confined almost entirely to suggestions as to how Government or other agencies may assist in solving the problem of persuading the cultivator not to burn cowdung?—Yes.

A.922. You have provided us with certain facts and given references, the effect of which is to show that the actual calorific value of cowdung in relation to its value cannot be taken as sufficient reason for the practice of burning cowdung in place of coal?—Dr. Watson has proved that in a paper which has appeared in the *Indian Trade Journal.*

A.923. But you point out that apart from custom there is in this connection the matter of convenience in that the fuel is not burned in a fire-place with a chimney, but it is very often burned in the open house in a *chulha*?—Yes.

A.924. Dried cowdung gives a slow smouldering fire which, I suppose, is ideal for certain practices of cooking; is it not?—I suppose so.

A.925. Do you not think the difficulty of getting a fuel other than cowdung which gives a steady heat for long periods without any flame or smoke is one of the principal reasons why cultivators insist upon using cowdung?—Yes, that is the principal difficulty. When villagers use coal they let it burn outside until they have a glowing smokeless fire, which they then take into the house and use for cooking purposes.

A.926. And it goes on glowing for a very long time?—Yes, until the coke is exhausted.

A.927. Without any chimney?—I believe so.

A.928. Do you suggest that there are any practical steps in the way of promoting the wider distribution and cheaper production of coal that Government might take which might be expected to lead to a substantial reduction in the amount of cowdung burnt?—I cannot suggest any action that Government could take. It seems to me the main point is to bring home to the cultivator the value of cowdung, and by raising its price enable coal or coke to compete with it.

A.929. I want to turn for a moment to the note on fertilisers to which I made a reference. You give there full information about all that has been done in the way of a survey of those various products and natural deposits. Do you think that that survey is complete, or do you think that other deposits ought to be discovered or made available?—Do you refer to any particular deposits?

A.930. No. Let us take them one by one. What about rock phosphates?—I do not think there is any likelihood of any extensive deposits being found. I have a staff of only 30 to deal with the whole of India, and one cannot cover very much ground during the year with such a small staff. But there is no likelihood of large deposits being found.

A.931. I take it nitrate of potash deposists in old towns and villages may exist almost to an unlimited extent?—The extent to which they exist is unknown.

A.932. What about limestone? Is that a substance which exists in India?—That is a universal product that could be obtained anywhere in India. There is no lack of limestone in the country except in particular districts.

A.933. And gypsum?—Gypsum is fairly universal; there is not very much in Madras and the Central Provinces, but in the Punjab, and Burma there are large quantities of it.

A.934. What is your method? Are you carrying out a further survey in detail throughout the country?—Yes; we have parties working in each Province and we also undertake enquiries regarding any special problem that crops up, the testing of dam-sites for instance and questions of that nature.

A.935. You are gradually building up a more detailed and complete survey than that which exists at the moment?—Yes. All our information is published as soon as available.

A.936. What about the Indian States?—We have in the past done a good deal of work in the Indian States, but according to a recent order Indian States are now asked to pay for such surveys, so that they sometimes refuse to have them.

A.937. Is it your view that there may be important deposits of mineral fertiliser in Indian States which have not yet been discovered?—No.

A.938. How far do your responsibilities go? Merely the discovery and recording of those matters, I take it?—Yes.

A.939. Are you concerned at all about advising anybody about the technical methods of extraction?—We help as much as possible, but we take responsibility for nothing of that sort.

A.940. Nor, I take it, do you interest yourself in the geographical position of those deposits in relation to areas where soil deficiencies exist in the neighbourhood?—No; we have not taken up that side of the work.

A.941. That is important in relation to the heavy charge for transport?—Yes.

A.942. *Sir Ganga Ram:* Does the official note* contain an account of the deposits in the Indian States?—It has reference to British India mainly; if we had any information regarding Indian States it would be mentioned there.

A.943. *Professor Gangulee:* With regard to phosphatic manure for this country, you are definitely of opinion that we cannot look to rock phosphates for the supply of that manure?—Yes.

A.944. What about Trichy nodules?—They have been examined. We have no information as to quantity because it is difficult to estimate; they occur in lenticular patches and one cannot very well measure them.

A.945. So, we will have to depend on bonemeal for phosphatic supply?—Yes.

A.946. You are definitely of the opinion that that is the only source that India can take to?—We can supplement that with a certain amount of phosphates.

A.947. Not to any great extent?—No.

A.948. As regards second grade coal, have any experiments been done with regard to its calorific value?—Yes; there are figures regarding different qualities of coal.

A.949. What about quantity?—An estimate was made by Sir Henry Hayden 4 or 5 years ago, and his figure was 78,000 million tons of coal in the country. I suppose out of that about 75,000 million tons would be second class coal. That estimate was based on mining only to a depth of between 500 and 1,000 feet; if you went to 2,000 feet you might say there are 150,000 million tons.

A.950. Do you consider that that presents a hopeful field for the expansion of fuel supply?—The amount of coal available may, for practical purposes, be regarded as limitless.

A.951. *Mr. Calvert:* Do you think there is a large field for the use of coal dust and charcoal dust for village fuel?—Do you mean first class coal or second class coal?

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* Not reprinted: Note on India's Resources in Mineral Fertilisers in memoranda prepared by the Government of India for the Commission.

A.952. Dust coal and dust charcoal, which is wasted?—With dust coal you will still get the smoke. With wood charcoal you do away with the smoke difficulty.

A.953. From coal you get smoke?—Yes; with coal you will get the smoke unless it is burnt to coke first.

A.954. But charcoal is free from that?—You mean wood charcoal?

A.955. Yes?—Yes.

A.956. Have you any experience of charcoal briquetting?—No; it does not come within my sphere.

A.957. *Mr. Kamat:* At present a lot of minerals is exported from this country in a raw state. Have you considered the advisability of turning them into finished products in this country, so as to give occupation to the people?—Yes, Government are always willing to take any measure to encourage the manufacture of finished articles from the raw products.

A.958. Is literature available in your department if private enterprise comes forward to do it?—Yes.

A.959. *Rai Bahadur Bannerji:* You have suggested in this note of yours that if the value of the use of cowdung as a manure is taught to the people and they are given a cheaper fuel, perhaps a time will come when cowdung will be used mostly as manure. And you are also of opinion that enquiry should be made into the possibility of briquetting of coal slack with some inert substance to reduce the rate of combustion and the use of bellows to reduce the smoke to a minimum. Any experiment on briquetting coal dust should be conducted on second class coal. Is any experiment being made in our country in that line?—None that I know of.

A.960. Have experiments been made in England and other countries on briquetting of second class coal dust?—A mixture of clay and second class coal has, I believe, been used with a certain amount of success.

A.960*a*. And it had a certain amount of commercial success?—That I cannot say, but it does minimise the smoke.

A.961. That experiment is not being made now, and it will be sometime before it is taken up by anybody here. The people of India do not commonly care for the smoke, they even use steam coal. But generally they burn soft coke which has less smoke after it is rendered red hot (*pora* coal as it is called in Bengali). If the coal-owners manufacture a larger quantity of this soft coke, do you not think it will be in a position to replace cowdung altogether?—Yes; that is my suggestion.

A.962. How would you induce a large sale of this soft coke among the people in the interior of the country?—Raise the price of cowdung cake, and if possible lower the price of the coke.

A.963. Lowering of the price of coke has been done in two ways, first, by the owners reducing the price and, secondly, the carrying railways reducing their freight. Would you advocate a reduction of railway freight on soft coke by Government interference?—It is a question which I hardly feel competent to answer; it is not a geological question.

A.964. The Indian Mining Federation, the members of which deal with second class coal generally and most of whom have collieries in the Jharia fields which is coking coal, have approached Government with the request that the railway freight for soft coke should be reduced by 50 per cent, so that they may offer soft coke for fuel purposes. Do you advocate it?—It would certainly have the effect of reducing the price of soft coke, but I cannot say that I am keen on Government interference in things of that kind, from a general point of view.

A.965. What the Government will do is neither my lookout nor yours. If soft coke will be within the easy reach of the common masses, they may be induced to give up burning cowdung for fuel?—If we reduce it by 50 per cent I should say yes.

A.966. *Sir Ganga Ram:* Is there a central laboratory to make experiments on manures to be made out of these natural deposits?—I have a laboratory

in my office in which we carry out simple experiments of that sort, and the Government Test House at Alipore carries out experiments on coal.

A.967. Experiments on natural deposits which can be turned into manure? Supposing I send you a natural deposit, would your laboratory give any results? —We could analyse it for you and tell you what it consists of.

A.968. Could you say by what process it can be made into manure?—Yes.

A.969. *Sir Thomas Middleton:* Has the Geological Survey carried out any special surveys of Government experimental farms?—No.

A.970. Has the Survey published any papers on the subject of the relation of soil to rock formation?—The only paper of that sort which I recollect is the paper by Center on *reh*. It is a very old paper.

A.971. At the present time, are your survey parties exclusively engaged in the mineral areas?—No, we have survey parties doing purely scientific work.

A.972. On what scale do they map?—On the largest scale for which we can get topographical maps.

A.973. 6 inch maps?—6 inch maps are not available in this country.

A.974. What do you get to work upon?—One inch maps.

A.975. *Sir Ganga Ram:* Are those maps for sale?—They are for sale by the Survey of India.

A.976. *Sir Thomas Middleton:* Are the Geological maps published?—They are published in our publications with the reports.

A.977. They are not issued separately for sale?—No.

A.978. Have you any general geological maps of Provinces on a scale of about 25 miles to the inch?—We have a map on the scale of 32 miles to the inch, which we are now revising.

A.979. Published for All-India?—It has never been printed yet; it is all coloured by hand, but the new edition we are going to have printed off in colour.

A.980. What is available to the public at the present time?—Various maps which appear in connection with memoirs.

A.981. *Dr. Hyder:* Your paper is based on the paper contributed by Dr. Watson?—Yes.

A.982. What would be the manurial value of a maund of cowdung? At present, if cowdung is used as mannure, what would be its value in rupees?—I understood it would be about 11½ annas a maund.

A.983. That was in the year 1908?—Yes.

A.984. You do not possess the figures for the present year?—I have been trying to get them.

A.985 According to Dr. Watson's paper, its manurial value would be 11 annas per maund, and when it is used as fuel its value is 4 annas?—As fuel its value is 4½ annas.

A.986. So, this country loses, on every maund of cowdung burnt as fuel, about 7 annas?—Yes.

A.987. That is the net loss to agriculture?—Yes.

(The witness withdrew.)

The Commission then adjourned till 9-30 A.M. on Wednesday, the 8th December, 1926. For proceedings of meetings of 8th December 1926, and 5th to 7th January 1927, see Volume IV, and for 13th to 19th December 1926, see Volume V.

Monday, January 10th, 1927.

PUSA.

PRESENT:

The MARQUESS OF LINLITHGOW, D.L. (*Chairman*).

Sir HENRY STAVELEY LAWRENCE, K.C.S.I., I.C.S.
Sir THOMAS MIDDLETON, K.B.E., C.B.
Rai Bahadur Sir GANGA RAM, Kt., C.I.E., M.V.O.
Sir JAMES MACKENNA, Kt., C.I.E., I.C.S.
Mr. H. CALVERT, C.I.E., I.C.S.
Professor N. GANGULEE.
Dr. L. K. HYDER.
Mr. B. S. KAMAT.

Mr. J. A. MADAN, I.C.S.
Mr. F. W. H. SMITH. } (*Joint Secretaries.*)

Mr. G. S. HENDERSON, N.D.A., N.D.D., Imperial Agriculturist, Pusa.

Replies to the Questionnaire.

QUESTION 1.—RESEARCH.—(*a*) (*i*) *and* (*ii*) I have dealt with this at large under Question 4, Administration. Veterinary work should be an essential part of any development in Agriculture.

(*b*) *and* (*c*) The Agricultural Departments have so far merely touched the fringe of the possible problems for investigation and research. It is my opinion that the first step should be that of setting the administration in order and an orderly survey made of the means available for an organised attack on the present terrible state of agriculture and livestock in India.

Some crops have had more attention than others, but there are crops such as potatoes of great importance which have had little attention. The whole question of grading of export crops needs thorough investigation, probably drastic legislative action will be required to raise the standard of Indian agricultural exports. This has been found necessary in other countries. An example may be quoted of Canada regarding wheat and Australia regarding dairy produce. The whole field of agriculture and livestock in India is in the greatest need of investigation and research. It hardly seems possible to name any lines of work which would not directly or indirectly give most valuable results, if properly prosecuted. The great dangers of course are misdirected effort, waste and extravagance, and in my opinion the real duty of the Central Government is to direct effort and public opinion along proper lines. Money is always available for the prosecution of research either from the trade or from the public interested. It would be a thousand pities to see a number of different agencies all working independently and not using their energies in the best possible manner. India is certainly coming within sight of such a state owing to the number of independent bureaux and committees which are being established simply because there is no central body strong enough to take them all into its fold.

QUESTION 4.—ADMINISTRATION. In my opinion the stage has now been reached in the history of the Agricultural Departments of India at which the greatest necessity is a thorough revision and reorganisation of the existing administrative system.

The most outstanding feature of the growth of these departments in India is that their expansion has been extremely unequal. The original plan was that a staff of experts with a central teaching institution should be provided for each of the Provinces in India. In some cases the Provinces began with some sort of agricultural organisation and so got a good start. An examination of the present budget of the various Provinces reveals this startling difference and this difference appears to be steadily increasing year by year. On one hand we have the Punjab spending Rs. 14,00,886 in 1924-25 and on the other side Assam spending Rs. 2,72,768 and Bihar and Orissa spending Rs. 4,81,629. This means that different parts of India are being catered for in very different degrees. Other factors which complicate the situation are :—first, the Provinces have purely political boundaries; in some cases they are less homogeneous than is the continent of Europe; also homogeneous tracts spread through two or three Provinces. The second important factor is that there is a large area under Indian States which in many cases are practically independent.

If the present state of affairs continues, some of the Provinces will have a very large organisation and will completely overshadow not only the other Provinces but also the agricultural machinery of the Central Government.

The original idea of the Central Agricultural Department at Pusa was a body of scientific experts divided into the following sections :—

1. Chemical section,
2. Agricultural section,
3. Mycological section,
4. Bacteriological section,
5. Botanical section,
6. Entomological section.

The Heads of these Sections were presumed to be experts of such standing that they carried weight in their branch of agricultural science throughout India. They were situated at Pusa as a convenient centre or more probably from motives of economy as the Pusa Estate was lying vacant. The Director of Pusa was the co-ordinating Head and the department as a whole was represented by the Inspector General of Agriculture who kept in touch with the Central Government and by means of extensive touring, was acquainted with conditions in all Provinces. His advice was in request by the young departments. This post was then abolished and the Director of Pusa and Agricultural Adviser to the Government of India were vested in the one incumbent.

In my opinion the time has now arrived for a thorough consideration of this situation. It seems to me that the Department of Agriculture under the Central Government has been too closely associated with Pusa. The name Pusa and the Central Agricultural Department are almost synonymous. The only exception follows on the creation of the Section of Dairying situated at Bangalore. Hand in hand with the extension which has taken place in some of the Provinces, there should have been expansion and extension not so much of Pusa, as of the Sections. Some of the Sections should have expanded and established centres in other parts of India if anything like the original proportion was to have been maintained.

The present situation is further complicated by the establishment of various central committees and bureaux dealing with special crops, such as the Central Cotton Committee and the Sugar Bureau. There is a branch of the Central Cotton Committee concerned with cotton work situated at Indore. The Head of this establishment is called the Agricultural Adviser to the Indian States and Director Plant Breeding Institute, Indore, and is under a practically independent committee.

The political aspect under the new conditions following the Reform Scheme is all important. Where the Directors of Agriculture are in touch with current political affairs, there is a much greater likelihood of getting the requisite financial support and machinery for expansion. In some Provinces the Director is a member of the Legislative Council, in other cases, he deals with the Minister concerned, chiefly through permanent secretaries and under-secretaries. Difficulties may be caused by the situation of headquarters and other factors. These factors have a large bearing on the success of a department. In the Central Government the Head of the Agricultural Department has to be frequently present with the Government in Simla and Delhi while his main headquarters is at Pusa and he has to do heavy touring to keep in touch with all the Provinces in India.

We can now consider what the situation would be in the event of the large extensions which are foreshadowed in some of the Provinces being given effect to. It would be possible to carry on as at present with Pusa as the headquarters of a body of scientific experts comprising the advisory staff attached to the Agricultural Adviser to the Government of India. In this case, the general tendency undoubtedly would be for Pusa to turn into a very centralised body having less and less connection with current agricultural affairs in India, as the development of the Provincial Agricultural Department increased.

The retention of the present Board of Agriculture or even an enlarged body in its place would do little to help matters.

The chief criticism of this state of affairs would be that practically all initiative would pass from the Government of India in agricultural affairs. It would be very difficult to see how problems which affect two or more Provinces could be properly taken in hand. Questions affecting trade, export crops and large Indian States would probably remain in abeyance. The Government of India is responsible for questions of a national character in India and it does not seem these can be suitably solved by handing over the direction of affairs to be dealt with piecemeal by provincial departments. We have heard the cry from a Provincial Director of Agriculture, "We want no interference from Pusa"; by this is meant the Central Department of Agriculture, but it is hardly likely that the Government of India would ever interfere even in the remotest way with any purely domestic question in a Province.

The simplest and most logical method of expansion for the Central Agricultural Department might have begun about the time when owing to the growth of the provincial departments, it was found expedient to replace the Covenanted Civil Service Directors by members of the Agricultural Service. At this time the Heads of the sections at Pusa should have been raised to at least the grade of Directors of Agriculture and made responsible for the activities of their sections throughout India. If this had been done, a thoroughly sound nucleus would have been available for eventually building up a business-like department on sound lines. No action of this nature was taken with the inevitable result that work at Pusa tends to become more and more divorced from that being done in the Provinces. Senior members of the Agricultural Service fight shy of any of the Pusa posts largely because it is realised that coming to Pusa means their chances of promotion in their own Provinces are very greatly lessened and also because advantages of proportionate pension are not given to members of the Central Agricultural Department though they are members of an All-India Service.

One effect of the Reform Scheme is a considerable tightening up of financial control. Audit inspections are much more rigid, and in a subject like experimental agriculture, the ordinary audit principles suited for the large routine establishments of the Government of India are totally inapplicable. The result is a considerable amount of interference, loss of time and diversion of staff from proper work to explain elementary facts to the audit officers. As an example of this, some of the members of the Agricultural Section had to be diverted from their research work to try to explain to the audit staff such questions as the following:—

1. Why self-binders and reaping machines lie idle most part of the year?

2. Why some cows calved every year while some only calve once in two years?

3. Why is it not possible to purchase stores in the cheaper season to avoid loss due to a rise in the market? These are a few examples from the report of about 80 pages of objections.

As the financial hold increases, the general tendency will be to hold the Director of Pusa personally responsible for all the work and gradually decrease the limited powers and initiative orginally vested in Heads of Sections. In my opinion it is this fact that lies at the bottom of much of the criticism raised against Pusa.

The Government of India must have a strong central executive body to co-ordinate and to advise on all questions of agricultural nature in India. They must have the machinery for keeping in intimate touch with provincial agricultural affairs. Some Provinces seem to think that any central authority should merely be of an advisory nature, but such is hardly possible. There are innumerable difficulties. In the stress of political conflict, the authority of such a body would probably be null and void.

Such central executive authority has been found necessary in all parts of the world and a very good model for India to copy would be the Central Department in the United States of America. The Head of the department must be a member or have a representative in the Assembly. He should rank as a Secretary to Government. As it is a physical impossibility for any one man to tour India sufficiently intensely to be thoroughly informed about local conditions, three or four experienced agricultural officers are needed to keep the central authority in touch with the provincial authorities. It would be necessary to take an officer for each division with considerable experience in that class of agriculture, *e.g.*, a man who has done his ten to fifteen years in the Madras Agricultural Department would command weight as a representative for South India and so on. The machinery would be built up as funds and facilities are available for the establishment of branches or divisions, one for each staple crop, one for each of the present Sections of Pusa if needed, one for agricultural machinery implements, one for irrigation, one for livestock and dairying, one for trade questions dealing with the grading and quality of India's export crops; manures would also have to receive attention. Other divisions required would be publicity, meteorology, education, statistics and publications, and liaison machinery for co-ordinating with the Irrigation Department, Forest Department and the Veterinary Department, etc.

A mass of details would have to be carefully considered, but unless some plan on the above lines can be evolved, it is difficult to see how the future Government agricultural work and its allied branches can avoid falling into a chaotic state. There is no reason why in the event of some such organisation being established, the relation between it and the Provincial Agricultural Departments should not be perfectly harmonious. One of the disadvantages of provincial rule is the water-tight compartments into which various tracts of similar agricultural areas are divided. The Central Department might avoid overlapping and would obtain much quicker development by arranging working agreements in the case where neighbouring Provinces have homogeneous tracts or where they are working on one problem under similar conditions. To take two concrete instances, Sind and the South Punjab, secondly Eastern United Provinces, North Bihar, North-West Bengal; these are cases in point of homogeneous tracts running through several Provinces which could very easily be grouped together.

If the above scheme is contrary to the Government of India Act and the Devolution Rules, I still think that before any form of body composed of Directors of Agriculture is formed, the Central framework must be considerably strengthened and the Head of the department put on a higher plane than is the case at present.

(*c*) (*ii*) *Railways and Steamers.*—The present situation in India with regard to freight haulage especially small parcels less than a truck load can only be

described as very bad. In long distance hauls especially where there is a break of gauge, the situation is extremely bad. There is invariable delay.

(*iii*) *Roads.*—In some districts such as Sind, roads are practically non-existent and camels are the only practical means of transport. Much could be done if funds were available.

(*iv*) *Meteorological Department.*—I am of the opinion that closer co-operation with this department and the Agricultural Department is required. It is more a provincial matter however than a central one.

QUESTION 8.—IRRIGATION.—The extension of irrigation by surface water from rivers, etc., and the utilisation of the underground water are both of vital importance.

Sind is an example of a country in which cultivation is practically impossible without irrigation. In other parts of India wells are of more importance. They generally extend the season of cultivation or help out a deficient monsoon.

The importance of well irrigation can be seen by the fact that some 16,000,000 acres are commanded by wells. The difficulties in the way of expansion both of wells as well as of large canal projects are chiefly those connected with finance. The questions asked under this head refer to districts and any general answers would be of no avail.

QUESTION 9.—SOILS.—(*a*) (*i*) Under this head I would instance a method on new lines which has been adopted for improving waste lands at Pusa which are subject to heavy flooding in the monsoon. There are considerable areas of this class of land in North-East India where large rivers coming from the hills are headed up by the Ganges in flood and considerable areas are periodically flooded. In the case of Pusa, the land was of a coarse sandy nature and grew rough grass and jungle practically unsuited for any economic purpose. After flooding, the land dried very rapidly and cropping was too precarious to render it practical. Some four years back about 180 acres of this land was gradually levelled as farm bullocks were available and irrigation pumps were provided at convenient spots along the river. When the land was fit to plough after the floods had abated, *berseem* or Egyptian clover was sown. This gave several grazings until the hot weather started. Thereupon maize was sown which was gradually cut for fodder until the rise of the river prevented further work. No attempt was made to keep the land from being flooded. It has been found that this system works very well combined with a dairy herd of cattle. Green fodder is provided at a critical part of the year.

(*ii*) *Reclamation of alkali land.*—I had experience in this class of work before coming to India in a large reclamation work at Lake Aboukir in North Egypt. I did some work on these lines in Sind at Dowlatpur and at Sukkur. I am a member of the standing committee of the Harappa Bara Reclamation Farm in the Punjab. I submit a copy of the bulletin* on this subject.

(*b*) (*i*) Where leguminous crops have been cultivated and grazed with cattle, a very marked improvement on the soil has resulted in every case.

(*ii*) Examples of deteriorated soil can be found on any large irrigation canal, especially near the main channel owing to seepage and percolation.

(*c*) This is a matter for local settlement in each case and no general rules could be laid down.

QUESTION 10.—FERTILISERS.—(*a*) Fertilisers could be used profitably to a much greater extent than they are at present on all capitalists crops and garden crops.

(*b*) I do not think there is at present any extensive fradulent adulteration of fertilisers.

(*c*) It is a matter for district propaganda work for the usual methods in each district.

(*d*) North Bihar for sugarcane.

(*e*) Investigation on the effects of manuring is required in every area. It is a matter which requires very much further extended investigation.

*Not printed.

(*f*) I think that far too much fuss has been made over the practice of using cowdung as fuel. I think it is a question which might well be left alone.

QUESTION 11.—CROPS.—(*a*) (*i*) The ideal method of dealing with the question of the improvement of an existing crop in an area is, first of all, a survey by a qualified botanist possibly helped by an experienced agriculturist, then botanical work at headquarters followed by the establishment if necessary of seed farm and demonstration plots. Where such procedure is not possible a great deal can be done for the improvement of existing crops by every agricultural station. Pure line selection can be done by every agriculturist of the staple crops with which he is working. It should be strictly laid down that this is an essential part of the duty of every station dealing with crops in India. Agricultural selection has been going on in the Pusa Farm for a considerable time and the special selections which are now being grown will be shown to the Commission.

(*ii*) One of the best examples of a new fodder crop is the introduction of *berseem* (*Trifolium Alexandrium*). This had been tried on small plot scale only in India previous to 1907. Suitable seed from the alkali lands of North Egypt was introduced into Sind during the following years and this valuable fodder crop is now found from the North-West Frontier Province to South India. It is an irrigated white clover and gives a heavy yield of succulent fodder from November to April-May where irrigation is available. It is a most valuable rotation crop and produces fodder abundantly during the critical months before the break of the monsoon.

(*iii*) and (*iv*) are local questions.

(*b*) In many cases it is quite possible to substitute a heavier yielding food crop, but before this can be done with safety, local conditions must be thoroughly investigated. In most districts there is cast-iron custom as to the staple food grain, and if another grain is grown it may be found that there is no demand for the new grain. For example, in a *juar* eating tract, *bajri* will not be eaten. So also a heavy yielding rice may be entirely unsuited for the consumption of a particular tract.

(*c*) Three of the most successful efforts of improving or substituting more profitable crops are in my opinion the following:—1. American cotton in the Western Punjab; 2. Coimbatore canes in North Bihar; 3. Pusa wheat all over India.

QUESTION 12.—CULTIVATION.—(*i*) This is a local matter.

(*ii*) In all rotations more importance should be given to leguminous fodder crops especially in irrigated land and the possibility of grazing of these crops by cattle should be considered.

QUESTION 13.—CROP PROTECTION.—I am of the opinion that present measures are suitable provided that provision can be made for immediate expansion under circumstances of necessity.

QUESTION 14.—IMPLEMENTS.—The question of the smaller agricultural implements is a domestic one as the requirements, say in the case of ploughs, vary according to the district, nature of land and other factors. There are several Indian manufacturers of ploughs, etc., and they have sold considerable quantities of cheap ploughs modelled on samples imported from abroad. The copies are quite good though somewhat roughly finished, but they are wanting in the fact that the plough bodies and shares are made of a poor class of metal which quickly wears out. For plough shares a high carbon content steel is required if the plough is to last for any length of time. The local manufacturers in India should be encouraged to use a better class of material.

The larger and costly agricultural machines suitable for special circumstances and large landowners, etc., are more a matter for the Central Government. There are a number of difficulties to the spread of such implements and machinery. In some cases, the proper type of machine has not yet been evolved. In my opinion when agricultural machinery of a type suited for a

particular purpose has been proved successful, there will be no difficulty in getting it taken up as a commercial proposition. Such machinery is not likely to be manufactured in India in the near future. It is very specialised work and there must be possibilities of large sales before any manufacturing engineering firm will evolve a new type. In the past there has been many failures, as the actual manufacturing firms are not in touch with local conditions. They usually employ agents at the big ports, that is Bombay and Calcutta, and these agents also are frequently not in touch with local conditions. They carry as a rule a very limited stock of spare parts and they are chiefly concerned in getting a cash sale without having any particular care as to whether the machine is suitable or not. A very important problem at the present moment is the production of a suitable threshing machine. There is nothing at present in the market which actually is suitable for conditions in the wheat tracts of North-West India. I have been working on this problem a number of years in conjunction with several implement manufacturers in Great Britain, but I have not been provided with sufficient means to make any great progress. An attempt was made in the year 1919 to get the Society of Motor Traders and Manufacturers to hold agricultural tractor demonstrations in India. This would have been of great value in bringing out to India actual manufacturers of agricultural machinery who could have seen the market possibilities at first hand. An example of the extended use in India without any Government action or propaganda work is that of the almost universal use of rice-hulling machinery. All conditions seem to me favourable for rapid and extensive use of harvesting and threshing machinery for the large wheat areas, provided the proper type of machine is available. India is one of the few large wheat growing countries where the grain is cut by hand and threshed with bullocks.

As a prime mover the steam engine is possibly most suitable to India than small internal combustion engines. This applies to agricultural tractors.

QUESTION 16.—ANIMAL HUSBANDRY.—(*a*) The methods for improving live-stock depend largely on suitable financial equipment. Work so far has merely touched the fringe of the subject. There is necessity of central co-ordination as well as prosecution of the work already started by various Provincial Governments. The whole subject was pretty thoroughly gone into during the last Board of Agriculture at Pusa by a special Livestock Committee and I heartily supported the resolutions come to at that time; copy* is submitted.

(*b*) The questions are chiefly of local significance.

(*c*) The period of extreme scarcity over the majority of India is at the end of the cold weather and up to the break of the monsoon. Cattle which survive are so emaciated that when the flush of grass comes on with the first rainfall, there is very considerable loss owing to digestive troubles.

(*d*) It is possible in many cases to grow fodder crops and where irrigation is feasible, leguminous fodder crops should be in all rotations. Silage in pits and the storage of grass and *kadbi* would be encouraged by all means.

QUESTION 17.—AGRICULTURAL INDUSTRIES.—(*a*) This all depends on a number of local circumstances, the period during which bullocks are worked will be lengthened if the cultivator does carting work or uses bullocks for water lifting. The actual working days in Sind might amount to 100 or 120.

(*b*) and (*d*) I am not in favour of Government intervention.

(*c*) and (*e*) to (*h*) I have no suggestions on (*c*) (*e*), (*f*), (*g*), and (*h*), except the fact that there is always far more employment in Sind than there are labourers available and the same applies to Bihar. As long as this is the case, I see no reason for encouraging subsidiary industries.

QUESTION 18.—AGRICULTURAL LABOUR.—The measures to attract agricultural labour must vary in every district and no useful general rule can be laid down. It is not possible in all cases to bring labour from some tracts to others. For example, attempts to attract labour from Gujarat into Sind have been a failure in every case. The colonists either die or quickly

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*Not printed: *vide* Proc. Bd. Agr. in India held at Pusa in 1925.

leave the country. Punjabi colonists can live in Sind and immigrants from the desert country of Rajputana come to Sind each season especially in years of scarce rainfall, but they generally depart after staying only a short time with what wages they have accumulated.

QUESTION 19.—FORESTS.—The questions under this head are largely local, but in one case the destruction of forests on upland country which occurred gradually in Chota-Nagpur has not only led to soil erosion but the whole climate has altered. Early rainfall used to be frequent from April until the break of the monsoon. Instead, severe hot weather is found at this period so much so that it is not possible to plant out young tea bushes. So no tea gardens are now made in this area though there are several productive old gardens.

QUESTION 20.—MARKETING.—(*a*) to (*c*) I will confine my remarks to the question of wheat exported from India. This contains a large percentage of dirt; it also contains foreign grains such as barley, mustard and rape, it contains a mixture of soft white, medium white and hard red wheat all of which would obtain better prices if sold pure. Wheat is exported in bags and this necessitates very expensive handling, extra railway stock and huge dock areas as the bags have to be stored on raised plinths. The whole system is primitive and out-of-date. The trade interested however does not recommend any change and a thorough inquiry is necessary and very drastic action on the part of the Central Government.

(*d*) The method of posting market prices at the various markets as done in the Punjab for cotton and wheat seems to be a very sound piece of work.

QUESTION 24.—ATTRACTING CAPITAL.—(*a*) As a general rule, capital fights shy of agriculture in India though there is plenty of money available for special crops in approved districts such as tea. In order to get men of capital and enterprise to actually take up general agriculture, a change of attitude would be necessary on the part of those Provinces which have land to dispose of. At present no encouragement is given to outsiders. This policy is probably quite sound for political reasons.

(*b*) Owners of agricultural lands under the Permanent Settlement have little or nothing to do with the actual working of their property. They are practically nothing but tax gatherers. In other parts of the country, owners generally let their lands and it is very seldom that owners are found who actually cultivate their own land. A certain amount of good might be done if Government were to include in the Honours List rewards for cases of enlightened management and well conducted farming.

QUESTION 26.—STATISTICS.—Most of the statistics is dependent on the returns submitted by the lowest revenue official. In Sind this is the *Tapedar*. He is able to write his returns in the vernacular and is a very poorly paid man without any interest in the figures which he produces. Until a better medium is provided for the production of statistical material, I fail to see how any improvement or further complicated methods at headquarters will improve the situation. I inspected a case personally in Sind as to the returns about cotton cultivation and outturn. These figures remained constant year after year though it was obvious that there were large differences both in yield and in area grown. The actual figures of production were obtained from the cotton gins for comparison. It was found that the *Tapedar* usually put down 8 annas as a safe figure for his returns.

Oral Evidence.

A.988. *The Chairman:* Mr. Henderson, you are Imperial Agriculturist?—Yes.

A.989. You have provided the Commission with a note of the evidence that you wish to give. Do you want to say anything in amplification of that note before I ask you some questions?—No. I think it expresses all my views quite fully.

A.990. Would you give the Commission a short account of your own training and past appointments?—I have been connected with agriculture all my life. My father was a land agent and I was trained in the West of Scotland Agricultural College. I was assistant to Sir Patrick Wright for two years; I was in Canada for some time. I then went to Egypt as an assistant in a land reclamation company. From Egypt I got an appointment in the Indian Agricultural Service and was stationed in Sind for about 10 years. From Sind I was appointed Imperial Agriculturist at Pusa. I was on the Cotton Committee for a year and then I was sent to Mesopotamia as a Special Commissioner along with Sir Thomas Ward, who was head of the Irrigation Department. From there I was put on special duty on the Indian Munitions Board. After that I went back to my substantive appointment and was on deputation in England for several months to organise motor tractor trials in India. Since that date I have been stationed in Pusa.

A.991. Would you tell the Commission whether you think Pusa a suitable site for this Institution?—I consider it should be one of several sites; I do not think the Institution or the Imperial Department of Agriculture should be confined to any one site.

A.992. If this scheme of instituting several stations at various places were carried into effect, would you suggest that one of those stations should be a headquarters?—I think possibly it would be better to have headquarters in touch with the Government of India and not necessarily at a station.

A.993. How about post-graduate training; that would have to be concentrated at one station or another, would it not?—I think the ideal form of training would be to have a certain time at several stations.

A.994. Upon the assumption that only one station is to exist, what do you say about the suitability of the site at Pusa?—It is not a good site.

A.995. Why?—It is hopelessly out of touch with the rest of India.

A.996. It is difficult of access?—Extremely.

A.997. Would you attach importance in the choice of a site to its accessibility to visitors coming to India as well as to persons resident in India?—I think that is a most important point.

A.998. *Sir Henry Lawrence:* Do you say it is a most important or the most important?—A most important point.

A.999. *The Chairman:* Then you look forward, I gather, to a day when the institutions carrying on research and responsible for demonstration in India will be in far closer touch with like institutions the world over?—Yes.

A.1000. *Professor Ganguleе:* Do you think that difficulty of inaccessibility can be overcome?—If railway facilities were improved or a bridge built across the river, it would be greatly improved.

A.1001. *Sir Henry Lawrence:* Or aeroplanes?—Yes.

A.1002. *The Chairman:* What exactly is the extent of your personal responsibilities?—I am primarily in charge of the farm and the cultivation of the whole of the area except some small pieces which are in charge of the various Sections. I am called upon to advise on purely agricultural subjects practically all over India.

A.1003. Are you ever called upon to advise upon problems of propaganda and demonstration?—I have done.

A.1004. Are you responsible also for keeping the records of experiments carried on on the farm?—Yes.

A.1005. Men come and go, and it is very important, is it not, that records should be both accurately kept and readily available?—It is most important.

A.1006. Are you satisfied with the system of recording experiences?—I think the staff is not quite adequate.

A.1007. Is the system sound?—I think the system is quite sound.

A.1008. Do you depend to a great extent upon articles in agricultural journals as records of events, or do you record matters on some definite system of filing or indexing?—Articles in journals as a rule are merely abstracts or summaries; they do not give elaborate series of figures; the figures on which results are based are kept in the office.

A.1009. Do you find that you are able to turn up facts that are required expeditiously?—Yes, we have no difficulty about that.

A.1010. Turning to the note of your evidence on the first page you say it is your opinion that the first step towards progress should be that of setting the administration in order and that an orderly survey should be made of the means available for an organised attack. What exactly do you include there by the word " means "?—All existing agencies.

A.1011. I wondered whether you were thinking of finance as well?—And finance.

A.1012. Have you any suggestion to make as to how money might be provided for a campaign of this sort?—I should think the first step would be to bring the necessity of it to the attention of the public and specially to sections of the public; for instance, a trade problem, if it were properly represented, would in many cases get very ample support from the trades interested.

A.1013. Do you think the public, whether through corporations or by private subscriptions from private individuals, might make an important contribution to the funds required?—I think they would.

A.1014. I see you attach importance to the question of grading of export crops and you suggest that drastic legislation may be required to raise the standard of Indian agricultural exports. Do you think the time has come for an attempt to fix what I may call All-India standards for exports?—I think it is high time.

A.1015. That would mean action of a disciplinary nature at the ports probably, would it not, judging by the experience of other countries?—It would probably have to go further back. In some cases the crop would have to be dealt with before it came to the port.

A.1016. So that the action required to improve the quality has got to be taken at a stage far removed from the port?—Not necessarily, because in the case of cotton a certain amount has got to be done at the gin which, in every case, is really the nearest point to the cultivator.

A.1017. On page 124 you say, " It would be a thousand pities to see a number of different agencies all working independently and not using their energies in the best possible manner." Do you envisage the possibility of combining all the existing agencies under one supervising head?—I would not go so far as that but I should certainly think there ought to be much more co-ordination.

A.1018. Take the Indian Central Cotton Committee. What do you think of that organisation?—I think it is a very sound thing. I was responsible for the drafting out in the first instance.

A.1019. Do not let modesty stay your hand. Tell us if you are satisfied with your work now that you see it in being?—I think it is rather apt to go too far. I think when it was originally established it was the only possible means of carrying out a certain object; but I think, however, that it is only in the nature of a temporary measure.

A.1020. What makes you think that?—If the Indian Central Cotton Committee expands as it is doing just now and gets in a staff, that staff might be working without any co-ordination with other agricultural workers even in the same Province. You might have a Cotton Botanist working on cotton and quite close you might have a Wheat Botanist working on wheat; the same man might quite easily be doing both things.

A.1021. You would not favour the idea of a committee having particular organisations devoted each to one part of the country?—Yes, if they are co-ordinated; but if the committee is going to be independent, then I think it is not a step in the right direction.

A.1022. Is one of the advantages of the Indian Central Cotton Committee this that it brings the growers and the intermediaries who carry on the distribution of the crop, those who process the crop in various stages and those who export it, into touch with each other and the Government?—I think the great advantage is that it brings the cotton worker, the trade and the Government into touch, but I do not think that it fully represents the interests of the cultivator.

A.1023. Can you suggest any means whereby the cultivator might be more adequately represented on the organisation?—I think that would follow if you had more co-ordination.

A.1024. More co-ordination between what?—More co-ordination between the Central Committee and the different Provincial Agricultural Departments.

A.1025. Do you think that the Committee is the body best qualified to speak for the cultivator? Is that your point?—No; I think the provincial departments would be better able to do that.

A.1026. Not necessarily the Imperial Department?—No.

A.1027. Do you wish to say anything about agricultural education?—No; I have not had much experience.

A.1028. Have you anything further to say about demonstration and propaganda? Have you much experience of that side of the work?—I had when I was in Sind, but since I have come here I have not had much experience.

A.1029. Do you form the view that the demonstration and propaganda organisation in the Provinces is as efficient as the research organisation?—I think it tends to lag behind.

A.1030. Is it because those responsible tend to spend more of the money that is available upon research than upon propaganda and demonstration?—I think that is so.

A.1031. And after all, propaganda and demonstration form the essential link between the laboratory or the experimental field and the cultivator?—Yes. I think the importance of technique (good farming) is sometimes lost sight of.

A.1032. I have one or two questions on the organisation at Pusa before I proceed to deal with your ideas on administration. Are you satisfied with the co-ordination of departments within the organisation at Pusa?—Yes.

A.1033. Is it one of your responsibilities to see that there is sufficient co-ordination between department and department at Pusa?—No; that is the work of the Director.

A.1034. But you are satisfied with the degree of inter-connection and inter-communication that exists?—I think it is very satisfactory.

A.1035. What have you to say about the co-ordination between Pusa and the provincial agricultural organisations?—I think it varies very considerably. We are in very close touch with some Provinces, but in other Provinces the case is quite different.

A.1036. How do you account for the difference between Province and Province in this respect?—In some cases a Province wants the advice of a man who has had experience in that particular Province. For instance, the advice of a man who has had his training, say, in the North-West of India would be discounted in Madras, and this is especially so in my particular Section.

A.1037. We spoke a moment ago about post-graduate training. Have you anything to say about the desirability of establishing at Pusa, or wherever the central farm may be, an active and efficient organisation for post-graduate training?—We can as at present constituted, give a very good training here, with certain limitations.

A.1038. You are satisfied with the equipment for that purpose, I take it?—Only for a part of the training; not for a complete training.

A.1039. Are there not graduates undergoing post-graduate training at Pusa at this moment?—In my section two have been appointed and will shortly come to Pusa.

A.1040. Do you regard the figure of two as satisfactory for an All-India station?—I am afraid it is not in our jurisdiction in a way. These students are nominated by Provinces. We have no selective powers.

A.1041. Do you think that you are in a position to supply the teaching that is required? Do you think you are meeting the demand?—We have been meeting the demand as at present.

A.1042. Are you yourself satisfied with the figure of two? Do you think it shows that the school has a good name in India as a post-graduate school?—This place was never established for the purpose of a teaching establishment.

A.1043. Would you attach any importance to the establishment here of the tradition of post-graduate training?—I consider that Pusa from an agricultural point of view has been too much specialised to give a complete training. They might do part of the training here.

A.1044. Do you think that the establishment of a post-graduate school which would carry weight throughout India would be of advantage to the research side of the work of this Institution?—If we had the equipment and the means, certainly it would.

A.1045. In what respects do your equipment and your means fall short of the ideal?—In my own Section we have a staff which is only calculated to do the work without any educational duties to discharge. We have not any special staff for educational work and we are very short of buildings at the present moment. Only about two-thirds of my staff have quarters; I am not quite sure of the figure, but at any rate a large number of my staff have got no quarters.

A.1046. I will take you back to the matter of your notes. On page 125 you talk about administration and you say that the provincial agricultural organisation is developing unevenly. You say, "On the one hand we have the Punjab spending Rs. 14,00,886 in 1924-25 and on the other side Assam spending Rs. 2,72,768 and Bihar and Orissa spending Rs. 4,81,629." You do not contemplate Assam being in a position to spend for sometime as the Punjab is spending, do you?—No, but the proportion should be much higher.

A.1047. Do you know the conditions in Assam?—Yes; I have been in Assam several times.

A.1048. Do you think that Assam could find the money to spend a great deal more on agriculture than is at present being spent?—I think that the money could be found in Assam.

A.1049. Do you think that the stimulus of a fully developed central organisation acting in concert with the Assam Government might induce them to spend a larger sum of money each year? It that your idea?—Not only that but we would then be in a position to help them.

A.1050. To help them to find the money or to help them to spend it?—To help them with money and to advise them in the spending of it.

A.1051. Do you accept the Reforms of 1919 so far as they affect the provincialisation of agriculture as a subject, and its transfer as something lasting?—I am afraid I am not really in a position to give evidence on that point.

A.1052. Then to change the subject: I see on page 126 that you complain of being teased by the Government audit. Do you not see any means of escaping from them?—I think the audit might be more on a commercial basis.

A.1053. If you succeed in commercialising a Government department, then you will succeed in doing something which nobody has managed to do before. On page 127 you say, "central Executive authority has been found necessary in all parts of the world and a very good model for India to copy would be the Central Department in the United States of America." Are you familiar with the workings of the Central Department in the United States?—Yes; I spent six months in the States.

A.1054. When you say "executive authority outside the matters over which the central organisation has specific control," how much actual executive authority has the Central Department in America over the affairs of the States?—I will give you a concrete example. Some years ago there was a great cry about dry farming and it was published all over America what could be done in States like Texas. The result was that a large number of ranches were broken up and settlers were induced to come from the East and take up these areas on the specific advice of the States Governments. The Central Government then stepped in and established several experiment stations on the dry farm areas and they gave absolutely contrary advice to that of the State of Texas.

A.1055. They made public advice conflicting with that given by the State?—Yes.

A.1056. Is there any executive authority over the State?—I do not know.

A.1057. *Sir Henry Lawrence:* What was the result of the divergent advice?—It prevented a large number of settlers coming from the East and saved a lot of money.

A.1058. *The Chairman:* Probably if they had had any executive authority they would have exercised it in preventing the movement: but the position, in fact, is that they have no such authority. Do you wish to say anything about the problem of indebtedness amongst the agricultural population?—No.

A.1059. Do you wish to say anything about fragmentation?—No.

A.1060. In answer to our Question 4 (*c*) (*ii*) you say, "The present situation in India with regard to freight haulage, especially small parcels less than a truck load, can only be described as very bad." Is that a question of freights or conveniences?—In actual practice it may take a couple of months to get stuff up from Calcutta to Pusa.

A.1061. So it is a matter of service rather than of the freight rates charged?—Yes, the service.

A.1062. Further on you say: "In long distance hauls especially where there is a break of gauge, the situation is extremely bad." I take it, you speak feelingly from having to change more than once every time you come from Calcutta to Pusa. On page 123 in answer to our Question 10 on fertilisers you say: "Fertilisers could be used profitably to a much greater extent than they are at present on all capitalists crops and garden crops." What exactly is the "capitalist crop"?—A crop like tobacco, sugarcane, etc.

A.1063. *Professor Gangulee:* You mean commercial crops?—Yes.

A.1064. *The Chairman:* You mean money crops?—Yes.

A.1065. Your establishment here is engaged in developing better plants of various varieties. Better plants, I take it, have a capacity for taking more nourishment out of the soil than the poorer plants?—In the case of grain, that is so.

A.1066. Have you come across cases where disappointment has been caused to the cultivator because he has adopted your better varieties but has not appreciated the necessity for giving them more food?—Not frequently, but I have met such a case.

A.1067. Can you conceive of a case in which the fertility required to supply a particular variety of crop with sufficient nourishment, so as to insure

that the land would not be progressively deprived of plant nourishment, would be so considerable as to make it hardly within the ryot's capacity to adopt it?—I think other factors come into play.

A.1068. You are, no doubt, familiar with that argument which has been advanced, are you not?—Yes.

A.1069. Now, in the matter of farm implements, do you feel that any substantial contribution is made towards the ryot's problem so far as that problem consists in improving his implements at this moment?—Yes, both directly and indirectly.

A.1070. Let us take " directly " first. In what way has it been met?—In many cases he has got an improved type of implement. I can give a case in point which happened in Sind. We introduced a new type of wooden plough. Last time when I was in that tract I did not see a single sample of the old plough.

A.1071. *Sir Henry Lawrence:* What type of plough was that?—It was an Egyptian wooden plough.

A.1072. *The Chairman:* Do you think there is a good deal more work to be done in that direction?—I think the work is only just begun.

A.1073. How is the problem being met by means described by you as " indirect "?—Take, for instance, cases like rice-hulling machinery. Rice-hulling machinery is very largely adopted and it is very largely to the benefit of the ryot. He indirectly gets a better price for his produce.

A.1074. I suppose the improvement of the breeds of draught cattle in India would probably be the most substantial indirect contribution towards the solution of this problem, would it not?—I think it is even better to prevent existing breeds from extermination.

A.1075. What do you think threatens the existing breeds with extermination?—In the case of the Saniwal cattle in the Punjab, the extension of irrigation has undoubtedly broken up the tracts which formerly supported large herds of cattle.

A.1076. You mean there are fewer cattle there now than formerly?—I do not say that.

A.1077. On this matter of cattle and the improvement of the breeds in India, do you think that a cross between European breeds and indigenous breeds is likely to make now, or in the future, a contribution towards the ryot's problem?—It might do it in the case where indigenous cattle are extremely bad. It has done it in a district round Patna.

A.1078. I do not quite follow you?—I say it has done it already in the district round Patna where the cross has been introduced and that particular strain of cattle is certainly better than the indigenous cattle.

A.1079. That is because the indigenous cattle were so very bad?—Yes.

A.1080. Could an equal improvement have been effected by the introduction of a better breed of indigenous cattle in that area?—I doubt it because the milk factor would come into play. This cross gave a much larger yield of milk and so it held its place.

A.1081. What breed of cattle are you referring to?—It is not a breed; it is only a strain. It is called the Taylor breed and various other names; but it is not a breed.

A.1082. That was a cross between a Kerry bull and indigenous cow?—I do not know whether it was Kerry or Shorthorn.

A.1083. *Sir Henry Lawrence:* When was that introduced?—I am not quite sure when it was introduced.

A.1084. *Sir Thomas Middleton:* It was introduced more than half a century ago?—Yes.

A.1085. *The Chairman:* Do you attach importance to the development of a dual-purpose animal capable of providing the maximum amount of milk and also providing males capable of effective work in the fields?—I think it

is very important, but I do not think it is as important as the taking of all possible steps to keep existing breeds of cattle uncontaminated.

A.1086. Are you familiar with the work which is being carried on by Mr. Warth at Bangalore on animal nutrition?—Yes.

A.1087. Do you attach importance to that work?—I attach very great importance to it.

A.1088. Do you think there is a great field still to be exploited in that direction?—Yes; I think the work is only in its preliminary stage.

A.1089. Have you ever thought about the milk-yielding side of the problem in its relation to the improvement of the diet of the cultivator and his family?—In some districts it is a very important matter. They say that in Sind it takes five cows to keep a family. That is an example of a milk-drinking tract.

A.1090. On page 130, in answer to Question 17, you say, "there is always far more employment in Sind than there are labourers available, and the same applies to Bihar. As long as this is the case, I see no reason for encouraging subsidiary industries." That, of course, I take it, means that in particular tracts where there is sufficient occupation, you would not spend any money in popularising subsidiary industries. In that answer, would you include subsidiary industries, or rather spare-time occupations, carried on by the women?—I have been many years in Sind and I have seen cotton lying on the ground because there were not sufficient people to pick it, and the occupation of picking is very largely women's occupation. So, I do not see the need of spending money in that direction.

A.1091. In those particular tracts?—My evidence is entirely in regard to those tracts.

A.1092. On the same page you point out the fact that migration of labour from one district to another is difficult, because it has sometimes been found to be the case that such labourers do not thrive in the district to which they go. Is it really the case that colonists going from Gujarat into Sind have died?—Yes.

A.1093. What killed them?—Probably malaria and heat.

A.1094. They could not face it?—They could not.

A.1095. On page 131, in answer to Question 19 "Forests," you say, "The questions under this head are largely local, but in one case the destruction of forests on upland country which occurred gradually in Chota-Nagpur has not only led to soil erosion but the whole climate has altered." Do you know whether the meteorologists of these days support the theory that deforestation affects the climate itself?—I do not know. My evidence is based on what I have been told by planters who have been in that district for many years.

A.1096. You are talking about pretty old times?—Yes.

A.1097. I am interested to see what you have to say about the marketing of wheat from the North-West. Is there great fluctuation in the volume of wheat available as the exportable margin from year to year?—Yes, very great.

A.1098. Would that be a serious difficulty in attempting to attract capital for, let us say, the modern system of marketing by means of grain elevators and ships designed to load from elevators?—It seems to me that there is a large amount of money invested in it at present; fluctuations do not seem to affect trade at present.

A.1099. Are you thinking of grain elevators?—Yes, grain elevators.

A.1100. Is there a large amount of money invested in grain elevators in the North-West now?—Little; there is only one grain elevator, so far as I know, in the whole of the Punjab.

A.1101. In what is this capital invested?—Rolling stock, docks and plinth areas.

A.1102. You know, of course, that for a fully developed system of export by means of elevators, you have to have not merely elevators, but also your ships designed to load from elevators? Would it not mean a very considerable tying up of capital?—On the other hand, it would free a lot of capital which is at present invested in rolling stock, harbour works, and godowns.

A.1103. Do you think that capital could be made liquid by an operation of that sort?—I should think valuable dock land could be sold.

A.1104. Have you any experience of agricultural co-operation in India?—Very little.

A.1105. Do you form any view about its usefulness as a contribution towards the agricultural problem?—I am not in a position to speak on it.

A.1106. Are you interested in general education in relation to agriculture?—I am hardly in a position to give evidence on that.

A.1107. In the matter of attracting capital, how would you suggest that the Provinces who are interested to do so might encourage outsiders to invest capital in agriculture?—Where Government land is being given out, conditions might be made to enable people with capital and with the proper knowledge to buy a certain amount.

A.1108. Are you thinking of establishing men on the land with large holdings, men who might be called planters?—Yes.

A.1109. Do you think that would be in conformity with present day policy?—To a limited extent.

A.1110. Do you come into contact at all with agricultural matters in the Indian States?—I have been on several advisory tours to Indian States.

A.1111. Is it your experience that Indian States are ready to co-operate with Governments in British India for the advancement of agriculture?—The States vary very considerably in that respect.

A. 1112. Are there any costing experiments being carried on at Pusa at this moment?—Yes.

A.1113. Would you describe a typical one?—We take a unit and all the work expended in cultivating that unit is put down daily.

A.1114. *Professor Gangulee:* For each crop?—Yes, for each crop. We have got complete data, since this place started, of the cost of cultivating every field.

A.1115. *The Chairman:* That is the cost of cultivation?—Yes, and of bullocks, but it does not include any overhead charges.

A.1116. Have you got the value of the crop?—We have the value of the crop and the outturn.

A.1117. Am I right in thinking that in an experimental station it is difficult to draw conclusions from comparisons between the total cost of cultivation and the value of the crop, because you are concerned rather with the carrying out of a particular experiment than making money?—That is so; and other difficulties arise, because it is not the case of one experiment; we might have a whole mass of experiments one overlapping the other.

A.1118. *Professor Gangulee:* Do you take into consideration bullock power?—Yes.

A.1119. *The Chairman:* So that, as a contribution towards the analysis of the cost of the cultivator's work, you are not really going very far here at this moment?—No.

A.1120. Do you think that might be a very useful field of work?—I should think it would be very useful indeed for a provincial department, not for a central department.

A.1121. Has any work on sheep been carried on at Pusa?—We have had sheep here for some considerable time, but owing to extensive flooding which we get in Pusa, we have had much damage from liver fluke; so, it is not a good centre for sheep.

A.1122. Have you done anything with goats?—Nothing.

A.1123. Is the goat an important animal in the agricultural economy of India?—Yes, it is important.

A.1124. You know the history of the improvement of milk-yields in particular breeds of goats in Europe?—I have read about it in agricultural journals.

A.1125. And the remarkable success it has attained?—Yes.

A.1126. Do you think that is a line which might be examined?—In some parts of India there are great possibilities for it.

A.1127. Have you considered at all the problem of whether the export of bones from India should be allowed or should be discouraged or prevented?—Under present circumstances, I would not be inclined to advise any interference with the export.

A.1128. *Sir Ganga Ram:* Not even an export duty?—No, I think I would not interfere in any way; not even an export duty.

A.1129. ***The Chairman:*** **Are you familiar with the Military dairy farms?** - Yes.

A.1130. Their cows are almost entirely first crosses between European and indigenous breeds?—They vary; in some farms they have got pure Indian cattle, and in others crosses.

A.1131. Their primary object is to provide milk for the troops?—Purely milk.

A.1132. Have you ever considered the possibility of the Agricultural Department taking over some or all of those farms?—I should be very sorry indeed to take over these farms.

A.1133. Why?—Because a lot of them are very badly situated.

A.1134. Have you coveted any of them?—One or two are very good; I would take Ferozepore.

A.1135. You think there is a case for taking that over?—I do not think so. If we took them over it would be in the nature of a compromise. I think it is very much better to acquire land and do the thing properly in the first instance.

A.1136. By compromise you mean that you have to undertake to continue the supply of milk and that will have to be carried on in conjunction with any experiment that you might wish to make; is that the point?—Yes; that is so.

A.1137. *Sir James MacKenna:* With reference to the organisation of the staff at Pusa and in the Provinces I see at one stage you say: "At this time the Heads of the sections at Pusa should have been raised to at least the grade of Directors of Agriculture and made responsible for the activities of their sections throughout India." Do I understand you correctly if I say you mean that you would have, at Pusa, the Imperial Agricultural Chemist as the Head of all the chemical work in India and the Economic Botanist controlling all economic botany in all the Provinces; that is the substitution in effect of several Agricultural Advisers for one, and with a great deal more power than the present Agricultural Adviser has? Is that your scheme?—Not exactly. I did not suggest that any section or extended section should have any power of interfering with the corresponding section of the Province; but that he should keep in touch with the work that his branch is doing in the different Provinces and be in a position to advise the Government of India on his particular branch.

A.1138. That is to say, you would have had advisers in all the branches of agricultural science, the Imperial Officer at Pusa advising on his particular branch of agricultural science to the Government of India?—Yes.

A.1139. In your experience of Pusa do you think that the Provinces would accept a scheme of this kind?—I fail to see why the Provinces should object; it is to their advantage. You instance the case of the Chemist. The Chemist probably is trained in a Province and he is in touch with the chemical work going on in all Provinces and so he is in a position to advise the Govern-

ment of India on his own branch. I think the Provinces will be quite pleased to have it.

A.1140. Is that your personal view or is that based on your actual experience? Have you found the Provinces so extraordinarily well disposed towards Pusa as to accept a scheme of that kind?—I have had no difficulty except in one or two instances.

A.1141. What is your view of the future organisation of the department in detail? How would you like the department to be organised with reference to Pusa?—My ideal is that the Imperial Department should not be so closely identified with Pusa. It ought to have stations in other parts of India.

A.1142. Then with reference to the Indian Central Cotton Committee, is it your view that the Committee has gone considerably further than what the Indian Cotton Committee had recommended?—Yes.

A.1143. You see a certain danger in it?—Yes.

A.1144. It has become too powerful altogether?—Yes.

A.1145. Are you in favour of entrusting special research on crops principally to the Central Committees and Bureaux?—I would have special branches of the Agricultural Department investigating special crops; but I would not give it over to independent bureaux. I would bring bureaux into the various branches of the department.

A.1146. You would insist on co-ordination of these bureaux? You are afraid they are apt to run away to their pet subjects and become rather too powerful?—Yes.

A.1147. Assuming that there was a centralised control of agricultural work in India, would you bring the Indian Central Cotton Committee under their control?—Absolutely.

A.1148. On the question of finance of these central bodies, you told the Chairman that you thought the trade could contribute as has been done in the case of the cotton crop. Do you think that will be feasible in the case of rice, for instance?—I think it would be to some extent. It has been done in the case of lac and cane to a certain extent.

A.1149. Would not the incidence of rice be rather unequal and fall rather heavily on certain Provinces?—Then the advantage would be to those Provinces more than to the others. But the amount is very small and I think it would not be a very heavy burden.

A.1150. You know the method of raising money for these central bodies by a form of tax or levy from the trade. Could not that money be earmarked for any particular crop from which it is derived?—I would not apply it to the particular crop.

In that case I must tell you what the case would be about rice. Even assuming a very low assessment, 80 lakhs of rupees would be paid by Burma alone and inter-provincial jealousy is likely to arise.

A.1151. One or two questions about your past experience. You had been Deputy Director for many years before you came to Pusa. Could you tell us in what way, if any, Pusa was of use when you were a Deputy Director yourself?—It was of very great use indeed. Mr. Mollison visited my place on three occasions. When he came to me on the first occasion I had not a bungalow in the place. After leaving me he went down to Bombay and saw the Government of Bombay and insisted on building me a bungalow. On the next occasion when he came he got a big grant for reclamation work and on the third occasion he got me more money.

A.1152. So the assistance was largely financial?—And advisory.

A.1153. But then he was Inspector-General. I want to know whether you got help from any particular section at Pusa during your Deputy Directorship?—As a matter of fact I did not get very much help because it was entirely a new department; Pusa had not been sufficiently organised to get much benefit from it.

A.1154. At present are the Provinces using your different sections?—Yes; a very large number.

A.1155. What problems of basic importance to agriculture are you looking to here? Will you just mention a few?—Cattle, upkeep of fertility and general technique.

A.1156. These are all enquiries of general importance to the Provinces as well as to local farming here?—Yes.

A.1157. Are there any other problems you have in mind that should be taken up on the agricultural side?—I should like to have increase of machinery.

A.1158. You think a lot of work can be done on that side?—Yes, but not necessarily by Pusa.

A.1159. Are there any limitations for the Provinces to fully utilise you?—I do not know of any.

A.1160. Are there not difficulties that have arisen under the new Devolution Rules in restricting the amount of touring and so on?—That comes under what I said about accounts.

A.1161. Now about your half-bred cattle, you hold annual sales here which are well attended and where very good prices are obtained. Are all these cattle inoculated by the simultaneous method before you put them up to auction?—Practically all. With a very few exceptions they are all simultaneously inoculated against rinderpest.

A.1162. Do you sell any cross-bred bulls?—No cross-bred bulls.

A.1163. Have there been any complaints from the buyers as to excessive mortality amongst these cattle as a result of rinderpest or other disease?—No.

A.1164. You have had no complaints from them that these cattle are more liable to disease than the ordinary cattle?—No.

A.1165. Are any obstacles put in the way of ingress to, or egress from, Pusa by the Railway Companies?—Yes. There are two Railway systems, the B. and N. W. Railway and the E. I. Railway and I do not think they fit in very well. Coming here from the Punjab, the Punjab mail comes in 20 minutes after the steamer leaves, which means staying the night in the station.

A.1166. Have no representations been made?—I believe representations have been put up but no action has been taken.

A.1167. Do you think that the teaching side should be extended at Pusa? Have you any ideas as to how you could improve it?—We should have a large number of short and special courses, for instance, in the installation of power machinery, the technique of cattle-breeding, fodder growing and so on.

A.1168. Do you foresee a day when Pusa will be able to give a complete post-graduate course in agriculture to qualify for direct appointments in the Indian Agricultural Service?—I should think it would be better if the course comprised a certain amount of training elsewhere in addition. I am talking especially of my own section and not of the scientific sections.

A.1169. How would you train these men for the Indian Agricultural Service?—In India now we have certainly got a nucleus for a very good training.

A.1170. Where?—Suppose they have taken their degree in one of the provincial colleges and they want to specialise, we will say, in cattle work, they can be given sometime at one of the Military dairy farms such as Bangalore, so long here, and a spell abroad.

A.1171. But would it not be better if we really had one institute where this class of teaching could be given, instead of waiting until one of the provincial colleges asserted its superiority and its position were recognised? —We could do it undoubtedly.

A.1172. Do you not think it has got to be done?—Yes; but I think the complete training should not be done here; I am talking from the point of view of the Agricultural Section.

A.1173. That is on account of the peculiar conditions under which you work here?—Yes.

A.1174. The limitations on the agricultural side?—Yes, you see we cannot give them any experience in irrigation.

A.1175. That is perfectly true. There is no wet cropping; so that really from the point of view of a complete agricultural course Pusa is unsuitable?—Yes, I think it is.

A.1176. It has these limitations?—Yes.

A.1177. *Professor Gangulee:* But you would have those sorts of limitations everywhere; could you select a spot where you would have all the facilities?—I would not select one spot, but I would arrange the course of training to get as many factors into the training as possible.

A.1178. Here you have already developed, if I may say so, a sort of scientific atmosphere; would you not prefer to utilise this institution for post-graduate training?—For part of the training but not the complete training. I think a man who is trained here and nowhere else would not be in a position to go all through India and be classed as a first class expert.

A.1179. Do you approve of the idea of developing Pusa as a post-graduate teaching institution?—Yes.

A.1180. Then if you agree on that point and if you have M.Ag. or M.Sc. students, do you not think you would have sufficient material here with which you could build up post-graduate agricultural education?—Do you refer to my section or all sections?

A.1181. The Institution as a whole?—I am not in a position to speak about the other sections.

A.1182. You refer to general technique in field experiments; are you working to develop a suitable plot technique?—Yes.

A.1183. For the purpose of carrying on experiments?—Yes.

A.1184. Do the members of the provincial departments visit your farm to study that technique?—They do on occasions; Boards of Agriculture and so forth come and study our methods.

A.1185. Most of the Provinces have to carry on experiments in the fields?—Yes.

A.1186. Are they familiar with your plot technique?—I should say they are, yes.

A.1187. Could you tell the Commission the procedure you adopt in planning your crop experiments?—I can give you full details; I am just starting a new series of plots on sugarcane in conjunction with the Imperial Bacteriologist and the Secretary of the Sugar Bureau. We are working on it just now and I can put all the documents at your disposal.

A.1188. Then you do consult with the other experts of the department?—Yes.

A.1189. In such field experiments you make an attempt to view the problem in all its aspects?—Yes.

A.1190. Do you attempt from an experiment to get complete data from all points of view? Can you tell the Commission whether you have carried on any experiments of that sort?—I am afraid I do not quite follow you.

A.1191. Let me explain. Supposing you are carrying on experiments with regard to the water requirements of a crop; you ask the Bacteriological Section to study the problem from the bacteriological side, you ask the Chemical Section to study it from that side, and you ask the Entomological Section to find out the incidence of pests in relation to water and so on; that is, when you tackle a problem do you try to get complete data in all its aspects?—Undoubtedly.

A.1192. Could you tell the Commission of any experiment that was done in that way?—We will take the permanent manuring experiment; this experiment was designed by the Board of Agriculture in India.

A.1193. You are referring to the Punjab field?—Yes. This experiment was designed by the Board of Agriculture but it has slight modifications since that time.

A.1194. I noticed this morning in going about the fields that you were carrying on various experiments with leguminous fodder crops?—Yes.

A.1195. Have you asked the Department of Animal Nutrition to ascertain the feeding value of these crops?—When they have got beyond the preliminary stages, we take all the necessary steps to try that.

A.1196. So that you are in touch with the Department of Animal Nutrition at Bangalore?—Yes.

A.1197. Have you at any time undertaken any experiments at the suggestion of the provincial departments?—Yes.

A.1198. For instance, has Bengal asked you as Imperial Agriculturist to carry on an experiment which they were unable to carry out? Can you give us an instance?—We are doing quite a large amount of work for the Director of Agriculture in Bengal, chiefly on fibre work; we grow fibre for him, we ret it for him and send him the result.

A.1199. Are retting experiments done here also?—In the last series of experiments we carried out, we tried to extract a fibre by mechanical means; this instrument was designed at Dacca and it has been tried here.

A.1200. So you do carry on experiments here at the instance and suggestion of the provincial departments?—Yes.

A.1201. Besides Bengal, has any other Province come forward and made suggestions to you?—I have had suggestions from the Punjab, I have had them from Bombay and from the Central Provinces.

A.1202. So that in that way you are in touch with other Provinces?—In touch every way.

A.1203. Has it been possible for you to verify any results obtained by the provincial departments in their field trials?—I cannot give any instance off-hand in the case of crop trials. If, for instance, a new fodder is recommended by a Province, we give it a trial here and see how it fulfils our conditions.

A.1204. In your note you say, "it is my opinion that the first step should be that of setting the administration in order and an orderly survey made of the means available for an organised attack on the present terrible state of agriculture and livestock in India." Do you suggest that up to now there has been no organised attack on the agricultural problems of the country?—No, I do not suggest that, but I have a feeling that development is going on very unequally, and I suggest that a further amount of co-ordination would be of very great benefit.

A.1205. So that your point is this; there has been an organised attack but not sufficiently co-ordinated?—That is so.

A.1206. Or, if I may say so, there has been an organised attack without sufficient organisation?—Yes.

A.1207. Whose fault is that?—The whole problem of agricultural improvement is absolutely modern; it has not had time to get going.

A.1208. And you think "setting the administration in order" would solve the problem?—It would, certainly, if it were on a business footing.

A.1209. When you speak of setting the administration in order, what have you actually in mind?—I have this in mind; we will say within the last 20 years the subject of improvement in agriculture under modern methods has been really started. It seems to me that we are going ahead in a very unequal manner; some Provinces are doing very good work and spending a lot of money; other Provinces are doing very little. Various semi-independent and other organisations are starting, and it seems to me that we shall get into a state of chaos if we go on like this; it is time that the whole subject was systematically gone into and some idea obtained of the means available for carrying out the work.

A.1210. For that purpose you propose to have a central body?—Yes.

A.1211. Let me see how you would form that central body. Would you call the Imperial Department of Agriculture a central body?—It is a central body, yes.

A.1212 Then how do you explain this, that this Imperial Department of Agriculture, which you admit is a central body, did not succeed in establishing a system of organised attack on agricultural problems?—Because it has never yet had a chance. It is still in its infancy.

A.1213. After 20 years' growth it may be said to have reached the adult stage. On page 125 of your *précis* you state; "If the present state of affairs continues, some of the Provinces will have a very large organisation and will completely overshadow not only the other Provinces but also the agricultural machinery of the Central Government." Why are you alarmed at the possibilities of the Provinces developing a very large organisation?—I am not alarmed at all; I am only too pleased.

A.1214. Why do you think such development would overshadow and not assist the Central Government?—If they expanded to such an extent they would simply take all the best men away from the Central Government.

A.1215. There would be demand for better men?—Then the better men would be confined to a water-tight compartment. You would probably have your first class men in the Punjab and very inferior men elsewhere. There is no equality about the thing at all.

A.1216. Then, further on, you say with reference to Pusa that the body of scientific experts working in the Central Institute would have less and less connection with current agricultural affairs in India, as the development of the Provincial Agricultural Departments increased. I cannot understand why that should be the case?—That is only my opinion.

A.1217. Could you kindly explain why you anticipate this difficulty?—I anticipate that difficulty if you have an unequal growth of development in one place as compared with another place where you might have nothing at all. You would in that case get all your best men removed.

A.1218. But, in any case, if the tradition of Pusa is properly maintained there ought to be no danger?—I think there will be very considerable danger

A.1219. Would you agree with me that such difficulties could not arise if the organisation of the controlling body of experts were made sufficiently elastic and the personnel engaged in research were properly selected?—That would undoubtedly go a long way to meet the case.

A.1220. Then with regard to the Institute, what definite proposals have you to organise Pusa so that the work on the central farm and the central research station can be made inter-related and inter-dependent, thus forming an essential structure in the agricultural organisation of the country?—I would extend Pusa by having stations in other parts of India.

A.1221. You make a reference to the Central Department of the United States. Is not that really a correlating agency? You say that it is an executive body. I think the Chairman pointed out to you that it was not. I was in the United States for some time and my impression is that it is really a correlating agency?—I am open to contradiction, but I was under the impression that they had essentially executive functions.

The Chairman: I said that as regards certain specific subjects; for instance the regulation of export and the duty of protecting the country against the importation of plant pests and the like.

A.1222. *Professor Gangulee:* Apart from certain reservations which the Federal Government make, the departments are quite independent and they have entire freedom in their own organisation and administration?—But if the Central Government wanted to carry out investigations I was under the impression that they had the power to step into that State and carry out the experiment by establishing a station in any Province.

The Chairman: At their own expense.

A.1223. *Professor Gangulee:* Without interfering with the work done by a particular State?—Yes.

A.1224. Here we have a note presented to us by the Agricultural Chemist to the Government of the Punjab and he also says that the State Departments have entire freedom of action in their own organisation and pursue their own independent lines of research. And further he says that they get material encouragement and assistance from Washington and that States vie with each other in the matter of catching the eye of the Federal authorities in receiving their grants. You said that you paid a visit to Canada. Have you had an opportunity of studying the organisation of the central farms of that country?—Yes.

A.1225. Could you very kindly tell the Commission how the work of co-ordination and organisation of these central farms is carried on in the different parts of Canada?—The station I was at was Guelph and they had a central farm there at which they tried new varieties. Then they had a chain of subsidiary farms in different districts and from there the improved varieties spread right through the whole tract.

A.1226. Yes, they are developing a very great deal. I saw some of their organisers at the Wembley Exhibition and that was the impression I was able to gather. You say the central body should include the Director of Agriculture. Would you not include the representatives of the Irrigation Department, or the Co-operative Department?—I would certainly include them. They would be essential for closer co-operation.

A. 1227. You make a remark about the use of cowdung as fuel. Do you consider the practice of burning cowdung a serious one?—My experience is confined to Sind and I think it is not a matter of very great importance there.

A.1228. Have you had any occasion to study the conditions in Bengal or Bihar?—Not in Bengal, but to a certain extent in Bihar. A lot of cowdung is got off the roads and from grazing grounds and so forth and it is almost always in a very dry condition. I do not think that it is a matter of primary importance.

A.1229. Have you an Agricultural Engineer attached to the Pusa Institute?—No; I attend to that branch.

A.1230. Have you any arrangements for testing different kinds of machinery?—I have tested several lots of machinery and several implements in different Provinces. I have tested the threshing machinery at Lyallpur; I have tested various things at Cawnpore and at Poona.

A.1231. Are you in touch with any Indian manufacturers?—I have seen factories in places near Dharwar.

A.1232. *Mr. Calvert:* One page 124 of your written evidence you say, "The whole question of grading of export crops needs thorough investigation." Might I ask why you lay stress on export crops?—I think the point of greatest importance is that improvement could be effected most quickly on export crops. The other point of view is that the grading of non-export crops would be attendant with very considerable difficulty. I think that immediate benefit could be obtained by taking up export crops.

A.1233. But any improvement in the marketing of export crops would only lead to a better price of the portion exported?—Eventually the cultivator would get a better price for his product.

A.1234. It would not reflect on the portion consumed locally?—I think it would, indirectly, in course of time.

A.1235. But the total proportion of agricultural produce exported is a very small part of the whole?—Yes.

A.1236. So that that leads one to the charge sometimes brought against the Agricultural Department that they devote too much attention to the export crops and not enough to the home consumption crop?—It would not be a sound piece of business not to start work where you would probably get the quickest result.

A.1237. In the case of Bengal rice, I gather none at all is exported. You could not improve the export marketing of Bengal rice?—No, I should think the department should tackle the question of Bengal rice by getting better seed and bettering the facilities for buying seed, helping in the manure, etc.

A.1238. Would you like to offer any opinion on the charge that departments devote too much time to the crops that go to Europe?—No, I do not think there is really very much in that.

A.1239. Just a point which Professor Gangulee took up about certain Provinces going ahead faster than others with the development of the Agricultural Departments. You would not go so far as to restrain their progress?—Certainly not.

A.1240. The mere fact, to take your figures, that the Punjab can afford 14 lakhs and Assam only 2 lakhs would not be an argument to keep the Punjab back?—No.

A.1241. Suppose that applied to Pusa, would you object to other Provinces going ahead if Pusa could not secure the funds?—No.

A.1242. I have not quite grasped the point of your argument here?—It seems to me that at Pusa the Central Government are lagging behind. We started with a certain ratio, as it were, and the expenditure was pretty even all over the Provinces; and now while some Provinces are going ahead, others are lagging behind.

A.1243. The main object of all these activities is the welfare and prosperity of the agricultural class?—Yes.

A.1244. As long as that end is achieved it does not really matter whether the work is done by the department here or in a Province?—It seems that it pays the Punjab to spend their money and they are pleased with the result, and if that applies to the Punjab it applies equally to other parts of India as well.

A.1245. Would not the success attained in one Province serve, as a spur to more laggard Provinces?—That is to be hoped for, certainly.

A.1246. I was not quite certain about the trend of these arguments?—The trend is that the Central Government should spend more money and keep up the organisation of the Central Government in proportion as expenditure increases in the Provinces.

A.1247. The argument is a local argument applied to the position of the Imperial Department?—Yes, that is so.

A.1248. And similarly, you say later on that all initiative would pass from the Government of India in agricultural affairs. Why should not the initiative lie in the hands of more progressive Provinces?—In the case of a problem which is common to several Provinces it is a case for the Central Government to act. I do not see why the Punjab, because it spends a large amount of money, should advise Provinces like Madras or Bombay; as long as they are co-ordinating their domestic problems they are absolutely within their right.

A.1249. But a great deal of work done in individual Provinces is of All-India value?—To a certain extent.

A.1250. But you want co-ordination of authority. Work may be carried on in the Punjab which is of value to Madras but who is going to be the connecting link? Is it your opinion then that the co-ordinating authority should also have with it a body of expert research workers apart from the provincial workers?—Yes, I think so, there ought to be a staff of sufficient scientific weight to act as co-ordinating authorities. For instance, if a chemical problem is being investigated in the Punjab which is of value to Madras, you must have a first class Chemist at the headquarters to translate it into practice, otherwise the work going on in the Punjab may never be heard of in Madras.

A.1251. You do not contemplate a time when the provincial departments will have extended to an extent which would render an Imperial Department

unnecessary or redundant?—I do not see how that can be done very well because, if your expansion is so unequal, I do not see how it is possible to get rid of the Central Department.

A.1252. Take the case of your own department. What work are you doing now at Pusa which could not be done or is not being done in the Provinces?—Nothing. Everything I am doing could be done in the Provinces.

A.1253. It could be done by a provincial department?—Undoubtedly.

A.1254. In another place you suggest that the Heads of Sections at Pusa should have been raised to the grade of Directors of Agriculture. Were you thinking of their pay or of their official status?—Both.

A.1255. You do not think that their scientific reputation will be sufficient to give them the due weight?—No, I do not think it would be sufficient to give them due weight under the circumstances.

A.1256. Coming to the question of new crops, you say on page 129, "In most districts there is cast-iron custom as to the staple food grain." Do you not think you are a little too rigid there in view of the change of diet that is taking place in various Provinces?—I can only speak from my experience. I have known a case where in a *bajri* tract they would not eat *juar*, and in a rice tract they would not touch wheat. I have known of cases where new rice has been brought in from some distance and the people in that tract would not touch it.

A.1257. That may be merely the objection to something new?—I do not say the custom is unalterable, but I say it is very strong.

A.1258. It is hardly cast-iron; you have expressed it a little too strongly?—I do not mean to infer that it is absolutely unchangeable, but it is a difficulty in the introduction of new crops in many cases.

A.1259. Still, there is considerable evidence that new crops are being introduced and people are altering their consumption in response to them?—I do not mean to infer that my remark applies to all the new crops. In many cases when you bring in a new crop it is taken up with avidity; but I say that in some cases it does occur.

A.1260. Are you barring agricultural improvement through the introduction of new food crops?—Certainly not; I have merely pointed out a difficulty which exists in some cases.

A.1261. But it is not universal?—No, it is by no means universal.

A.1262. For instance, potato is spreading very rapidly?—Yes, and Pusa wheat is spreading very rapidly. I have merely instanced that as an obstacle.

A.1263. But it is not an insurmountable obstacle?—No.

A.1264. Now, with regard to the question of Animal Husbandry. Do you think that the sentimental view with regard to the cow is a bar to an improvement in the livestock?—I consider it a very great bar in some tracts.

A.1265. It is a great difficulty?—Yes.

A.1266. You say that the actual working days of bullocks in Sind amount to 100 or 120 days. Is that a guess or is it a careful calculation?—That is a calculation based on one particular village of which I have got experience; it is actual fact.

A.1267. On the question of marketing of wheat you say that "the trade interested however does not recommend any change and a thorough inquiry is necessary and very drastic action on the part of the Central Government." Do you stress the word "Central" there or would you allow Provincial Government to make the inquiry?—It struck me that it was a problem common to several Provinces. It is not only the Punjab problem but it is also the problem of Bombay and the United Provinces.

A.1268. Still the problem is sufficiently big in a single Province to justify an inquiry?—Undoubtedly.

A.1269. And actually the inquiry is being made by the North-Western Railway which is an Imperial department, but it might again be taken up by a provincial department?—Yes.

A.1270. Would you kindly let me know what you consider is the change of attitude necessary on the part of the Provinces in order to attract capitalists to take up agriculture?—In some Provinces it is more or less a settled policy not to encourage people from outside that Province to take up land.

A.1271. You are thinking of the Punjab probably?—As a matter of fact, I was thinking of Sind.

A.1272. What change of attitude do you want?—I do not want any change of attitude; I have merely suggested that that would be necessary if outside capital were to be attracted. I do not recommend it.

A.1273. On page 131 you say, "It is very seldom that owners are found who actually cultivate their own land." I presume you mean large owners? —I was referring to this side of India; this side of India is very exceptional.

A.1274. Could you make any suggestion as to how these owners could be encouraged to take a more active interest in agriculture?—I think Mr. Sayer made a suggestion sometime ago that if the Honours lists were more used for cases of advanced agriculture, that might help a bit.

A.1275. You do not think that has been done sufficiently now?—No. I know from my own experience as a Deputy Director in Sind that a recommendation, say, from the Police Department or from the Irrigation Department went very much further than a recommendation based on the fact that the man was a good zamindar.

A.1276. An opinion has recently been given by the President of the Science Congress that these new crops do not take more out of the soil than the old crops; that it is merely a question of getting a more efficient plant machine. Do you agree with that?—That can be absolutely proved or disproved by chemical analyses.

A.1277. What exactly is the general ideal that you are aiming at in the Agricultural Section? Is it to get crops which will make better use of the soil, ripen more quickly and take up less time, or to get a crop which will give a bigger yield?—There are several factors. In some cases it would be a matter of expediency to get a crop which could mature with less water; in some cases it would be more expedient to get a higher yielding crop; it is not always the same aim. The object might be to get an early ripening crop as we do here in Pusa. In many cases, I should think that if your crop gives a higher outturn, even at the expense of reducing the fertility, it is sound business to get a higher outturn and an immediate return unless fertility is going to be reduced very considerably; it is better to have the money at once if you can get it.

A.1278. One of the pieces of evidence given to us is that improved varieties require more careful cultivation and better manuring; is that generally true —I do not think it can be laid down as a general rule. It may be so in some cases, but unless the difference in yield is very considerable, I do not think there will be very much difference in the effect on succeeding fertility.

A.1279. As to the question of Honours, do you not think people will give up their farms when they get their Honours?—I should think it would have a very good effect in the district. After all, the same principle might apply in giving an Honour for anything.

A.1280. Do you think it might be of real permanent value?—I should think so.

A.1281. Do you not think that a certain class of men does work for Honours and a certain class of men does work for the sake of work, and that the latter is often the better man?—The man who recommends him is responsible for selecting the proper type.

A.1282. I should like to make the question about costings more clear. Is this inquiry in which costing is being done under your control?—We keep a record of all the costings of all the crops of this farm.

A.1283. Of the farm you showed us this morning? How is it entered up everyday? Do you enter the hours of labour?—We enter the hours of labour, the number of bullocks used and the actual operation.

A.1284. How are you going to assess the value of the work done by the bullocks?—If a pair of bullocks work for half a day, we put down their rate for half the day.

A.1285. Then you are putting down a conventional rate for the bullocks?—Yes.

A.1286. How is that arrived at?—On the basis of our experiences and also on the basis of what it costs to hire a pair of bullocks.

A.1287. But you have just said that you found that bullocks were used only from 100 to 120 days in a village. Assuming that to be correct, you have got to allow somehow for the cost for 240 or 260 days?—If you will read my evidence you will find that my figure refers entirely to Sind. We can get quite a good basis of comparison by the rate it costs us to hire a pair of bullocks. Of course, we hire a number of bullocks and we know the rate at which they are hired.

A.1288. That would not give you the cost of cultivation?—It gives an idea of what the bullocks cost.

A.1289. That would give you the cost of hiring the cultivator's bullocks, not the cost of cultivation?—That is what we have done so far.

A.1290. You are not trying to work out the cost of keeping a pair of bullocks for a year and dividing the cost by the number of days they work?—We have sufficient data to work it out quite easily.

A.1291. Are you in favour of a more intimate study of rural economics in this country?—Yes.

A.1292. Do you think it would be of value to you in your work?—It could not be of very much value in my present post, but I think it would be of great value generally.

A.1293. The major part of this country is cultivated in small holdings up to about 12 to 15 acres. Do you think the methods you are working out now are suitable for the small cultivator?—No.

A.1294. As far as I have seen, practically no attempt is being made to work out the type of cultivation suitable for these small holdings?—That, I presume, is being done by the Provinces.

A.1295. We have not yet found any Province where it is done. This machinery which you showed us is not suitable for the 3-acre man?—No.

A.1296. There is nothing being done here to try and improve agriculture as it is understood by 90 per cent of the agriculturists?—We are working on specialised problems. But although, as you say, the larger proportion of Indians cultivate it in very small fragments, still there is a very large amount which is cultivated in big estates.

A.1297. Big estates form a very small percentage of the total area?—And when you come to dairy work, it will have to be on a big scale.

A.1298. It practically means dairy work is outside practical politics?—No; I would not agree with that, because the milk supply of cities like Bombay and Calcutta must come within practical politics.

A.1299. You are not working out any model to copy?—The improvement of milk supply is the important point.

A.1300. Do you think there is any connection between this concentration of the various Agricultural Departments on large scale farming, and the failure of graduates of agricultural college, to take to agriculture?—I do not think there is any connection.

A.1301. You do not think the fact that agricultural graduates do not take to agriculture is because the agriculture they have learnt is not suitable

to the Province in which they live?—In the first place, you cannot teach practical farming in any educational institution; you have got to learn out in the open; you cannot teach business in an educational institute.

A.1302. When a man takes to medicine, he practises medicine, and a man who learns dentistry practises dentistry?—Before an engineer qualifies himself, he has got to put in five years in the workshops as a fitter.

A.1303. It would not apply to surgery, or medicine, or dentistry?—I do not think you can call an average doctor a business man.

A.1304. We have never yet been told why it is that these graduates from the agricultural colleges do not take to agriculture, or why they are not being employed by the big owners?—That applies to other countries also; I do not think, as a rule, a graduate of an agricultural college in Great Britain takes to practical farming.

A.1305. What is it that is special in agriculture, when those who learn it make more money by preaching it than by practising it? Where does the difference come in between agriculture and every other form of education?—Agriculture is purely empirical; any scientific work you learn should be a help, but it will not take the place of practical technique, and you can only learn your practical technique by the sweat of your brow.

A.1306. You have heard of the proposal in the Punjab to allot land to agricultural graduates for a period of years?—Yes, I have heard of it.

A.1307. Do you approve of it?—I think it would be a very interesting experiment.

A.1308. Do you think it would be sufficient to give the practical training required?—I think you would get a certain number of good men out of that lot.

A.1309. It would add to the value of the graduate?—I think it would.

A.1310. Do you think it is possible to standardise agricultural machinery such as ploughs to an extent which would permit of mass production? We have been told that if you could have half a dozen types of ploughs for India you might get a great reduction in the cost price by mass production; do you think it is possible?—I have a great hope in it; I think it is a development which will occur in the future.

A.1311. Do you think it will be possible?—I have great hopes about it.

A.1312. *Mr. Kamat:* You had the advantage of service in Sind; you have also visited Egypt, and you have had considerable experience at the Imperial Institute here. I should like to ask you, in view of this experience of yours, something about the possibilities of Sind. I do not wish to put any hypothetical questions, but I cannot resist the temptation of asking you for an expression of your opinion with regard to the future possibilities of Sind. Do you think, under an improved agricultural system, Sind will approximate in yield to Egypt, say, for a crop like cotton?—There are some very great disadvantages which Sind labours under. In the first place, it has got a very bad climate; its hot weather is probably one of the worst in the world; some parts of Sind have got an extremely bad type of malaria, and it seems it is getting worse.

A.1313. *Sir Ganga Ram:* Even worse than Bengal?—I think it is worse than Bengal. Another point is that you have got a very small population. I believe the population of Sind is about five millions and the area is about 40,000,000 acres. It is a very scattered country, and in most cases the soil is inclined to be impregnated with alkali or *kalar;* but provided the population difficulty is got over and you can get the right type of colonists into Sind, I should think it has got great possibilities. For one thing, it starts off with a great advantage; it has got excellent drainage; the subsoil water is very low. Egypt suffers very badly, because the subsoil water is high, and it has got the greatest difficulty in getting rid of this drainage water.

A.1314. *Mr. Kamat:* You are aware that the Bombay Government are making a huge experiment, from the financial point of view, in the shape of the Sukkur Barrage. Do you think that will help the Province of Sind to

improve matters and come up to the level of Egypt?—I am afraid it will take some considerable time. The difficulty, in my opinion, is the want of population.

A.1315. I want to take you to another general question which arises out of your remarks in the pamphlet* which you have placed in the hands of the members. While discussing the question of reclamation work and other work in Egypt and comparing it with similar work and its yield in the Punjab on page 9 you say, "It will only be by the adoption of suitable intensive rotations and the largely increased use of leguminous fodder crops and keeping and feeding increased numbers of livestock that the yields of irrigated land in North-West India will approximate more nearly to those in Egypt." You go on to say, "At present the average yields per acre in the Punjab canal colonies, especially on the older colonies, are very small and evidence seems to point to the fact that yields are decreasing." This is in comparison with Egypt. Do you still hold by that opinion?—Yes.

A.1316. This was written about 5 years ago. Are things improving or stationary, so far as your knowledge of the Punjab goes?—I think it still holds.

A.1317. Coming to your précis, you said you had only 2 graduates in your section receiving post-graduate training at the Imperial Institute here. Do you think matters could be improved?—We could train more if the Provinces sent us more students to train.

A.1318. Is it the difficulty that the Provinces do not send the students, or is it that your method of selection is defective?—The men we are training just now have been sent to us by the Provinces; they are members of the Provincial Service.

A.1319. *Professor Gangulee*: Out of how many applicants have you selected these 2?—Out of 3.

A.1320. *Mr. Kamat*. Does it not seem to you to be almost a tragedy that from a vast country like this there should be so few graduates coming up here, and that it reflects on the Imperial character of this department here?—The point is that if the educational facilities in the Province are so good, they do not need to send us men for training.

A.1321. Either the post-graduate training here must be carried on under more satisfactory circumstances, or it ought to cease, and the better course surely would be to have a larger number of graduates trained here. Have you not thought of the possibility of getting over this point, which perhaps has been due to methods of selection or some other consideration?—That does not apply, in my opinion. While this may not be a very suitable place from the agricultural point of view, from the point of view of other sections it may be a very suitable place. A man who wants post-graduate training, say, in entomology, is in quite a different position from the man who wants post-graduate training in agriculture.

A.1322. Have you any idea how many students go abroad to learn the same subjects which are taught here?—I have no information on that point at all.

A.1323. Are no figures collected?—No.

A.1324. Speaking about co-ordination, you have said that co-ordination between the Imperial Institute here and the Provinces varies from Province to Province. Where you thought such co-ordination to be lacking, have you ascertained its causes?—I do not think it is a case of lacking; people come to me if they think I can do them any good; if they do not believe I can do them any good, they do not come to me. I have given the example of Madras; they do not come to me on questions affecting agriculture, but they do come from other Provinces.

A.1325. In the case of Madras, for instance, when you say they do not come to you, have you ascertained the causes why they do not come to you?—Because they have got their own experts in Madras, who are probably

* Not printed: Notes on Practical Salt Land Reclamation—Bulletin No. 91 of 1920—by Mr. Henderson.

much better qualified to advise them than I am. I have no special experience of Madras; my special experience is in an entirely different direction.

A.1326. In that case, where for the time being, accidentally or otherwise, a situation like this arises, that is to say, an expert in the Province of Madras being as good an expert as at Pusa, there should be no complaint that there is not sufficient co-ordination, such a state of things is inevitable?—I do not know that there was a complaint.

A.1327. Then, in the case of those Provinces where the co-ordination is not as much as you wish, you have no complaint to make?—No.

A.1328. To come once again to this question of the administrative situation and your suggestion for revision of the position, I am not quite clear whether you have made the position clear or whether I quite follow you, in the light of the constitutional position of the country as it stands at present. Let us see how far we agree. You agree that as long as the Government of India Act stands as it is, agriculture must remain a Transferred subject in the Provinces and therefore the Province must be autonomous?—Yes.

A.1329. If that fundamental fact is accepted, the Government of India should have no right to interfere?—My opinion is that it should have no right to interfere with any domestic problem; but it should have the right to interfere where the problem is common to two or more Provinces.

A.1330. That is where we disagree. In any shape or in any form whatever, the two things are contradictory. If a subject is Transferred, constitutionally do you think it should remain in the hands of the Central Government even for purposes of the remotest point of interference?—I am afraid I cannot agree with you.

A.1331. Assuming that the Government of India should have no power of interference, should then the Pusa Institute have any power of interference, since the Institute is an advisory body either to the Central Government or to the Provincial Governments?—On broad lines my opinion is that it should have no power to interfere in a purely domestic problem. But when that problem ceases to be a domestic problem it certainly should have a right to interfere.

A.1332. In that case do you mean to say that a problem which is domestic in one Province and is also domestic in another Province becomes a central subject simply because it is common to two Provinces?—I do not follow you.

A.1333. You admit that a particular subject, say, a particular crop, is a domestic subject in one Province. It is also domestic in the adjoining Province. By mere virtue of the fact that the subject is common to two contiguous Provinces, does it become a central subject?—Yes.

A.1334. I think there again it does not seem to be perfectly clear; it is rather contradictory?—May I take a concrete point to illustrate my meaning? We might have a case where one Province was busy pushing out a certain type of cotton; this might be close to an area in a different Province where a very high class long staple cotton was being grown. By pushing this cotton out they might be radically injuring the good cotton and still, for political reasons, one Province might not be prepared to stop that cotton being pushed; that is a case where the Central Government should have power to come in and act.

A.1335. Yes, but act only in the shape of giving advice. But what you want is to go beyond the Government of India Act and invest the Central Government with powers of interference and initiative in certain matters which cut right across the very idea of the Government of India Act. Now about this proposal for revision of existing relations, there is some little contradiction in your suggestions. In one place you say, "It is hardly likely that the Government of India would ever interfere even in the remotest way with any purely domestic question in a Province." That is, you agree that so far as a purely domestic question is concerned, they should not interfere. But, in another place, in making suggestions on the lines on which the present administrative position should be revised you say, "The

Government of India must have a strong central executive body to co-ordinate and to advise on all questions of an agricultural nature in India." I cannot understand how a body could be executive and yet give only advice and co-ordination. If it is an executive body it will interfere?—A body of that nature would, I think, never interfere except in the case of absolute necessity.

A.1336. Now the question is, even in the case of absolute necessity, should it have, constitutionally, the power to interfere?—It seems to me that if it is going to be purely advisory, its functions may eventually be practically null and void.

A.1337. In which case would there be any harm in giving the Government of India power to interfere in the matter of Transferred subjects in the Provinces? Or would it be better to leave each Province to advance as it likes? Which would lead to the more chaotic state of affairs?—I might give a case in point. A lac institute has lately been established near Ranchi. In the course of time they will have a fully equipped Chemist and possibly a Botanist. Within a short distance of that there is an experimental station of the Agricultural Department. You might get two Botanists working within a few hundred yards of each other and doing work which one might do, and these cases will undoubtedly be multiplied in the future.

A.1338. I quite realise your difficulties and I quite realise also your desire. I do not wish you to misunderstand me. What we both desire is to have co-ordination and a machinery for co-ordination. But that machinery, I say, should be on the basis of advice on the part of the Central Government and in no case should it be in the form of actual interference; and, if you agree, then our task would be to suggest what sort of machinery these should be to secure better co-ordination. Now in order to achieve this end, that is to avoid interference, yet to have co-ordination we have been told in some other place that the only machinery possible under the present Act would be a Central Advisory Board in which your Institute should have an adequate place. Would you be satisfied with that?—I am afraid that would not be sufficient to fulfil the case.

A.1339. You do not then agree with Dr. Clouston's suggestion to have a Central Advisory Board to guide the Government of India and, through them, the Provinces? Would that be an adequate machinery for the kind of co-ordination which you desire?—I am afraid it would not.

A.1340. In what respect would such a Central Advisory Board fail?—We have had a good deal of experience with the Board of Agriculture which meets periodically. It is composed of representatives from all parts of India. It meets and passes resolutions.

A.1341. Supposing we get over that difficulty where the deliberations result purely in resolutions and we frame also a machinery to give effect to the resolutions of this Advisory Board, would you be satisfied? That is to say, there would be a permanent Secretariat attached to the Central Advisory Board and through the Secretariat a certain amount of correspondence would be carried on with the Provinces in order to ensure action being taken on the resolutions. Would that satisfy you?—The point is this. I am not in a position to argue with you on points of politics as you know them very much better than I do; I am an agriculturist. But it seems to me the most direct way is that the body which is going to be constituted should have executive powers.

Well then, we differ fundamentally, I am afraid.

A.1342. *Sir Henry Lawrence:* On the question of the development of Sind, you say that you foresee difficulty in securing enough labour for the land under the Sukkur Barrage and you give some figures as to the population of Sind and the area of Sind. I think you said 5 million of population and 40 million acres?—Yes.

A.1343. You do not suggest that the Sukkur Barrage is going to command the 40 million acres, do you?—No.

A.1344. The actual area commanded is 7½ million acres, is it not?—Yes.

A.1345. I think the actual figure of population in Sind is 3¼ millions and not 5 millions and about 2 millions would be living in that area?—Yes.

A.1346. Now can you tell me what is the amount of land cultivated per head of the population in other irrigated areas?—I cannot tell you off-hand. But it has been my experience that where you grow cotton, especially irrigated crops, you must have a fairly dense population.

A.1347. Will you agree that the area cultivated in places where cotton is grown is as high as 1½ to 2 acres per head of the population?—I think it is about that.

A.1348. So that the population of two millions may be able to deal with the cultivation of 5 million acres? Would you like to think over that?—I think it is on the small side. 5 million acres is the actual area of Egypt and the population of Egypt is much more than 2 millions, I think.

A.1349. Then Mr. Kamat got an opinion from you that the produce of irrigated land in the Punjab was decreasing. Is that a necessary result of irrigation, or is it due to some bad methods of cultivation?—I think it is due largely to economic conditions. They are rather apt to take too much out of the land in the first instance before they have got sufficient cattle, and they do not grow sufficient leguminous crops. But I think on the whole it tends to even up later on when the country becomes more settled. I base that evidence on questions which I put during the Cotton Committee to various officers and zamindars in the Punjab: they said that in their opinion on the older canal colonies yields were decreasing, in some cases very slightly, but still on the downward grade.

A.1350. Did you carry that further and ascertain the cause?—I put the cause down to the fact that wheat was very largely grown and that fodder crops were not cultivated in sufficient ratio.

A.1351. So that you would ascribe it to an improper ratio of cotton and wheat without the land being heartened by leguminous crops?—That is the basic cause in my opinion.

A.1352. But supposing you had a proper rotation with leguminous crops, is there any reason why the produce should decrease?—If a proper rotation is carried out and a heavy stock of cattle carried, all experience tends to show that the fertility will increase.

A. 1353. So that you want two factors; you want both leguminous crops and a sufficient head of livestock?—Yes.

A.1354. In regard to Sind, are you aware of what experiments are being made or are in process to ascertain the proper rotation of crops?—A considerable amount of work has been done already in Sind on this subject. There is a station at Sukkur on what was formerly very poor land but is now growing excellent crops.

A.1355. Is that station still maintained?—Yes.

A.1356. Are the lessons taught by that station propagated? Do people know of them?—The difficulty is this. An intensive rotation of that nature means a supply of water sufficient to grow two crops a year, and the conditions under which you can get the supply of water are at present limited. On the Sukkur farm the water is obtained by pumping from the river, and thus it can be regulated; but in any of the existing canals in Sind the amount of water is fixed and you cannot get more than this fixed ratio, so that it is impossible to carry out a really intensive rotation, but they get over that by having a large number of fallows.

A.1357. I do not fully understand. Do you think there are sufficient experiments being made now in Sind to prepare the way for the Sukkur Barrage?—A new station has been started but I have not seen that yet, but there is quite a lot of data available as to the result of intensive rotations.

A.1358. From the Sukkur and the Mirpurkhas farms?—Yes, and also to a small extent at Larkana.

A.1359. Have you ever advocated any further experiments being made in advance of the Sukkur Barrage?—In the Report of the Cotton Com-

mittee it is very definitely recommended that two such stations of at least 200 acres should be established.

A.1360. And what action has been taken on that?—One station has lately been sanctioned, but I believe they have already had difficulty about the water-supply, they put it in a place where it is not possible to get the water-supply as contemplated by the Indian Cotton Committee Report.

A.1361. Did you recommend any specific position for the other station? —No, we left that to the Local Government.

A.1362. *Sir Ganga Ram:* So that the experiment was not made?—The experiment has not yet been made.

A.1363. *Sir Henry Lawrence:* Is there any other situation that you know of in Sind where the water-supply is adequate?—The object was to reproduce post-barrage conditions, and that could have been reproduced by putting up pumps at certain selected sites on the river.

A.1364. And that is your recommendation?—That is the recommendation of the Indian Cotton Committee.

A.1365. Has that been communicated to the Bombay Government?—Undoubtedly, yes.

A.1366. But no action has been taken?—The action taken has been quite recently.

A.1367. But that is a different locality altogether?—Yes; our point in the Indian Cotton Committee was that it is essential to reproduce post-barrage conditions.

A.1368. In a recent meeting, I think of a scientific body, it was stated that the land in Sind was bound to deteriorate if it received heavy waterings: is that your opinion?—Who stated that?

A.1369. I think the President at a scientific meeting, Mr. Howard?—No, as the statement stands, it is not my opinion.

A.1370. What is the actual fact in your opinion?—Land can be damaged by heavy waterings if the water is improperly distributed; but the mere fact of putting heavy irrigation on land does not necessarily spoil it. Otherwise all rice land would be spoiled.

A.1371. *Sir Ganga Ram:* Does not heavy watering cause waterlogging?—It may, under certain conditions, but not necessarily.

A.1372. *Professor Gangulee:* It depends on the condition of the subsoil, does it not?—Yes.

A.1373. *Sir Henry Lawrence:* Did you find in Sind that the alkali there met with is soluble in water?—All the salt land of which I have had experience in Sind contained soluble alkali.

A.1374. And the irrigation can wash those salts down into the subsoil? —If you get sufficient irrigation you can wash it down into the subsoil.

A.1375. So that that is not a serious danger in your opinion?—It is a serious danger if there is not sufficient water; if there is sufficient water it is quite an easy proposition to wash the soluble alkali down into the subsoil in the case of Sind.

A.1376. Do you contemplate the establishment of a dairy industry in Sind?—I should think the dairy industry should be promoted by all possible means in Sind.

A.1377. I think you said that you were of opinion that a dairy industry would be of value to Sind?—Yes.

A.1378. Could you develop that a little more by giving grounds for it? At present in Sind there is a very good type of cattle called the Karachi breed. Do you expect that breed to spread to other parts of Sind?—I think when the canal becomes a going concern there will be a very big scope for dairying. It seems to me to be absolutely essential, on a canal of this nature, to have a large area of fodder crops and as there is an

excellent dairy breed in the Province, dairying and fodder growing will go hand in hand.

A.1379. Do you consider that the people there know how to treat their cattle properly?—My experience of the Karachi district is that the breeders are efficient.

A.1380. Do they understand the principles of breeding cattle?—In my opinion they do; and they also keep a note of the pedigree to a certain extent.

A.1381. That is a very rare fact in India?—Yes, it is.

A.1382. And do you see any other advantages that the dairy industry would have in Sind over other parts of India?—As the Province developes under irrigation you must keep up the fertility of the land, and it is necessary to increase the livestock population, otherwise I do not see how the fertility of the canal area can be kept up.

A.1383. In Sind would there be the same difficulties about the disposal of young male stock as is found in other parts?—I should think there would be a considerable demand for young male stock of good breed.

A.1384. Now to come to this question, which Mr. Calvert raised, of the use of Pusa to India: you have no experiments here in rice?—No.

A.1385. What is the reason for that?—It is not a rice country. We have really no rice land on the Estate.

A.1386. Is not rice grown a good deal in this Province?—More south of the river and in patches north of the river.

A.1387. So that for reasons of soil and climate you have not been able to carry out rice experiments. Pusa is not suited for the purpose?—No.

A.1388. Rice is the most important crop in India?—Yes.

A.1389. The next most important is millets. Is that so?—Yes.

A.1390. Have you had any experiments on millets?—Yes, we have grown practically all the standard millets, and we have had them on small and large areas.

A.1391. Have you been able to devise any method of improving the millet cultivation?—We have not done very much work on millets. It is not the staple crop in this district.

A.1392. From that point of view again Pusa is not suitable?—No.

A.1393. Not suitable to the most important agricultural interests in India?—That is so.

A.1394. It is not because you were induced to favour export crops, the money crops, rather than the crops of internal consumption?—No; we have naturally taken up work on the crops which are indigenous to the tract to begin with.

A.1395. In regard to your visits to Provinces you say you have been welcomed in some places and not welcomed in others. Do you wait to be invited to go to a Province or do you announce your intention of visiting a Province?—Under the present Accounts Rules you have got to be invited practically.

A.1396. What Account Rule is that?—The Accountant-General puts difficulties in the way of passing any travelling allowance bill unless there is a very clear reason for going to a district.

A.1397. Which Accountant-General is that?—The Accountant-General, Central Revenues.

A.1398. And has that position of the Accountant-General ever been disputed?—I shall have to refer you to Dr. Clouston on that point.

A.1399. Since when has this objection been taken?—Within the last two years.

A.1400. Actually have your travelling allowance bills been refused by the Accountant-General for want of a specific invitation from a Provin-

cial Government?—I will not go so far as to say that, but great difficulties have been created and questions have been put.

A.1401. In regard to experiments in cattle-breeding, you have tried crossing the local cattle with Ayrshire bulls. Have you obtained any other imported bulls?—We have had a limited number of American Friesian crosses but the majority of the crosses have been got by the Ayrshire.

A.1402. And the result of the first cross is very good in regard to milk supply?—Uniformly good.

A.1403. Continued crossing with the same Ayrshire, or foreign breed did not prove satisfactory?—That is so.

A.1404. Have you tried the further scheme of crossing with this year first cross-bred, the Sindhi, Montgomery or other Indian cattle?—We are now beginning on that work.

A.1405. You have not arrived at any conclusion yet?—As far as we have gone the results have been very satisfactory.

A.1406. That is quite a promising experiment. Has not that been tried in any other part of India?—I do not think it has been tried systematically on any large scale.

A.1407. Have you any knowledge of the experiments made by Mr. Borden in Texas, in connection with the importation of Indian cattle for the improvement of Texas cattle?—I have heard about them, but I have no personal experience. I am told they have proved quite satisfactory with regard to resistance to tick fever.

A.1408. That is to say, the quality is imported by the Indian sire and subsequently continued in the stock though the subsequent pedigree was entirely local. Does that not offer some hope for similar results in this country?—I think there is a promising field for that work but it must be done on a fairly large scale and there must be continuity of policy.

A.1409. Have you any knowledge of the milk question in Madras?—I have no first-hand information.

A.1410. Do you know that Madras milkmen attach considerable value to English blood in their milch cattle?—I have been told so.

A.1411. You have not had any opportunity of investigating it?—No first-hand knowledge.

A.1412. You showed us this morning some soya bean growing. Has that crop been successful in other parts of India?—Only as a fodder crop, not as an oil crop.

A.1413. Has it been grown for oil-seeds anywhere?—Only on a limited scale, as far as my information goes.

A.1414. Does it produce much seed?—Not a very big yield.

A.1415. But merely from the point of view of fodder it is worth growing?—It is very valuable in this place because it fills up the gap between maize and clover.

A.1416. During what months?—September and a part of October.

A.1417. For how long do you leave it in the ground?—It is sown during a break of the rains and is grazed in September and October.

A.1418. That is to say it is 4 months in the ground. How many grazings do you get from it?—Only one.

A.1419. *Sir Ganga Ram:* How long have you been in Sind?—I went there in the beginning of 1907 and left in 1916.

A.1420. In what capacity?—As Deputy Director of Agriculture.

A.1421. Do you know that the total population of Sind is only 3¼ millions?—I thought it was a little more.

A.1422. It may be a little more. During the last census it was 3¼ millions and already they have got ·93 acre per head of the irrigated area. In fact as regards the percentage of irrigated area they stand at

the top of India?—That is so because you cannot cultivate without irrigation.

A.1423. I mean irrigated area without the Sukkur Barrage. Do you know anything about the qualities of the peasantry of Sind? Are they good peasants?—Not particularly good cultivators.

A.1424. For how many working class people is the area already irrigated sufficient?—I should say that the great majority of the people are directly connected with the land.

A.1425. What I mean to say is that you may safely say one million will belong to the cultivating class so that for one million you have already got one million irrigated acres. Do you think that the people want more? —I take it the idea is to colonise and that the new works bring in colonists from other Provinces.

A.1426. Is that the idea?—I think so.

A.1427. Have you made any research as to the delta of water required to mature each crop?—I have had a certain amount of experience.

A.1428. Could you give me a list of those experiences?—Yes, I will send it to you.

A.1429. Have you made any experiments as to what each crop takes away from the soil and what each crop gives back to the soil in chemical properties?—No, not absolute chemical properties, but I have to a certain extent judging by the state of the succeeding crop.

A.1430. You have not made any regular analysis after the crop is cut?—We have never had a Chemist in Sind.

A.1431. For want of staff?—Yes. There is only one Deputy Director of Agriculture in Sind.

A.1432. You say in your note that after sugarcane you sow maize. Is that the proper rotation?—That is proved by the result.

A.1433. Did you try cotton after sugarcane?—This is not a cotton tract. I grow cotton occasionally.

A.1434. What is there against cotton?—The rainfall is very heavy.

A.1435. What is the area of your Pusa Estate?—The arable area is about 600 acres.

A.1436. And you think that a little irrigation will not improve prospects of research?—We have a certain amount of irrigation which you saw this morning but the main portion of the farm is not irrigated because the land generally in North Bihar is not irrigated, and if we get results from irrigation these would not apply to Bihar.

A.1437. Have you got a contour plan of your estate?—Yes.

A.1438. Can you send it to me?—Yes.

A.1439. I should also like to have any experiences that you may have in regard to the chemical properties, *plus* or *minus*, of your crops?—My colleague Dr. Harrison would be able to give you first-hand information on that.

A.1440. Perhaps you may make a note of that also?—Very well.

A.1441. Do you know the discharge of this river which goes through your Estate?—No, I do not know its discharge.

A.1442. What is the source of this river?—It comes from a big lake up in Nepal.

A.1443. Have the Canal Department ever considered the possibility of making use of it for irrigation purposes?—I do not think it is a feasible proposition because it varies so much. It floods very large areas during part of the year.

A.1444. What is your difficulty in the winter season when the rains stop? —It would have to be lifted.

A.1445. Is it not a fact that in this area round about this river you are generally free from famine, but sometimes on account of the stoppage

of rain you are confronted with famine?—I do not think we have ever been confronted with famine in this district.

A.1446. Is there any fall here? Is there any possibility of preparing a hydro-electric scheme?—The fall is very small indeed. It is so small that when the Ganges is flooded this river is headed up and it floods miles and miles of the country.

A.1447. Where is the fall?—Between this river and the Ganges.

A.1448. Do you know the velocity of this river or at least the fall in the river?—I have got no data on the subject. It is very small indeed. We are only about 60 feet above Calcutta level here.

A.1449. You said in your evidence that people eating *juar* would not take *bajri*, but the two things are grown in separate seasons. In Bombay they grow *juar* in the *rabi* season also?—My evidence applied solely to Sind.

A.1450. Not to Bombay?—No. I was talking about *kharif juar*.

A.1451. In Sind they do not grow *rabi juar*?—No.

A.1452. You recommend that Pusa wheat might be spread all over India. Have you any knowledge of the Punjab wheat which has now superseded Pusa wheat?—I have seen the different varieties grown at Lyallpur.

A.1453. Do you know that Punjab 8A is a better quality?—It depends.

A.1454. May I tell you the defect in Pusa wheat? It is not a very hard wheat for milling purposes and that is the reason why our 8A is very largely demanded; it is hard and just the quality for milling purposes?—Pusa 12 was a preliminary wheat. Quite a number of wheats are now coming on.

A.1455. Are they better than Pusa 12?—Yes.

A.1456. Have you ascertained any method of fixation of nitrogen from the air?—Yes, by means of leguminous crops.

A.1457. Anything else?—No.

A.1458. Not by very frequent ploughing?—No.

A.1459. Has not that led to fixation of nitrogen?—That I am not in a position to give an opinion on.

A.1460. How many times do you plough here for your crops?—For the *kharif* crops it all depends on various conditions; but we make it a rule to plough at least to 9 inches once in a year.

A.1461. Have you any section of the subsoil here?—Dr. Harrison has got that.

A.1462. Will you kindly make a note of that too?—Yes.

A.1463. In your written note you say there are 16 million acres under wells in the whole of India?—Yes.

A.1464. Have you any opinion to express on the necessity of grain elevators?—I should think they are absolutely bound to come sooner or later.

A.1465. Did you have any experience of them overseas?—I have seen them in Canada.

A.1466. How far apart are they?—There are elevators practically at every chief station on the railways.

A.1467. What I want to ask is whether the distance of carrying will **not outweigh the advantages of the elevator? How far apart are they?—** My recollection is that there are elevators at every station and these stations are probably 10 miles apart.

A.1468. Have you any experience of dry farming?—I have seen the dry farm stations in Texas.

A.1469. Is dry farming conducted because there is no rain?—Yes, there is very little rain. They do dry farming with a rainfall of under 10 inches.